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The Safety Movement Public recognition of well-doing is of more importance to a corporation than to an individual. The latter gets from it a little personal satisfaction, or, at best, a stimulus to increase his effort in the proper direction. Commendation of the corporation, however, does more than bring satisfaction to the constituent individuals or stimulate them to greater personal effort. It promotes faith and pride in the organization, a feeling that united efforts are more productive than those that are scattered. The organization whose employees are proud of its achievements and go out of their way to tell about them is marked for success. It is for this reason that the award of safety medals by the American Museum of Safety is of such importance. The employees of the United States Steel Corporation, of the New York Telephone Company, of the Allgemeine Electricitäts Gesellschaft, and of the Southern Pacific will be stimulated to greater efforts along safety lines now that their work has been recognized. The spirit of competition, too, will stimulate other corporations and their employees to greater activity.

The Shadow of Harriman The bestowal last week on the Southern Pacific of the Harriman medal for safety on railroads is a tribute to the "railroad side" of the late E. H. Harriman that, in justice to him, should not go unnoticed. It may be said that the award was made to the Southern Pacific in the face of strong opposition, for the committee of awards realized that there was danger of the charge of favoritism if the medal provided by Mrs. Harriman in honor of her husband should go to a "Harriman road." The evidence in favor of the Southern Pacific, however, was so overwhelming that the committee could not disregard it. To those who know only of the financial side of Harriman's work it may come as a surprise to learn that one of his chief concerns was for the safety of employees and passengers. His feeling in this regard was translated into practice on the roads he controlled. Knowledge of this side of the man's character, while not excusing his financial operations, should at least soften the criticisms directed at him for his financial manipulations and give him the credit that is his due.

Non-Expert Appointments Chicago has recently seen the futility of appointing non-experts to technical positions in the demoralization of the Lincoln Park activities under a superintendent whose previous qualifications consisted in the management of a baseball team and the unsuccessful operation of a bar. The superintendent has resigned and various civic organizations in Chicago are appealing to Governor Dunne and to the commissioners to appoint an experienced public-park expert, who can appreciate the large technical problems of civil engineering involved in shore reclamation and revetment work, in the construction and maintenance of the boulevards and portions of Sheridan Road, in the landscape-gardening features, in the administration and maintenance of playgrounds and in the upkeep of buildings. Former superintendents have filled three positions, those of secretary, civil engineer and superintendent. The work has grown too large for one man and hereafter the engineering duties will be carried on by an engineer reporting to the superintedent. It is said that under the past régime most of the competent engineers and the landscape gardener resigned or were forced out. A $4,000 chief engineer is sought by civil-service appointment, but the various playground organizations are fearful that the engineer will override the superintendent unless the superintendent is chosen first and presumably has a hand in selecting the engineer. The board could do worse than select engineers for both positions.

American Concrete Institute The establishment by the American Concrete Institute of a monthly journal is an indication of the intentions of the directors to increase the usefulness and influence of the institute. There are successful technical societies which confine their activities to an annual convention and annual publications. The American Society for Testing Materials and the American Waterworks Association, for example, are in this class, and are strong organizations. The American Concrete Institute, until recently known as the National Association of Cement Users, is still a very young organization, but its program—that of teaching the proper uses of cement and concrete and securing the adoption of proper specifications—is an ambitious one. To accomplish its purpose it will require the active interest of a large membership, and that interest can best be sustained by the establishment of a monthly organ. The institute has, therefore, been well advised in the step it has taken. It is manifest, of course, that the establishment of the journal brings up many difficulties. What material shall be published? Shall it be composed largely of papers presented at the annual convention, either in advance of or after the sessions? These papers certainly are legitimate material for such a publication, but it does seem that the departure points in the direction of local branches at which papers of less importance will be read at intervals during the year. Such meetings would supply an abundance of material for the journal and help still more to strengthen the organization. The Engineering Record hopes that the new publication will be a great aid in furthering the interests of the institute.

Buying Public Health That the preventable deaths in Chicago are equal to the Titanic death list every month is an appalling fact at which few appear appalled, according to Dr. George B. Young, the health commissioner, who makes an appeal to citizens to help the department obtain funds with which to reduce the increasing number of such deaths. That public health is purchasable—within certain limitations—and that a community can determine its own death rate have been demonstrated thoroughly, not only at Panama, but in large cities. Chicago has fallen behind in healthfulness and, Dr. Young states, is paying the price in losing the commercial advantage of being the healthiest large city in the world. The doctor is right in urging Chicago's budget makers to wake up and take steps to regain its lost prestige—a prestige which he declares counts far more heavily in a commercial sense than many thinking men realize. The department is asking for 16 cents per capita more than last year, bringing the rate up to 47 cents per inhabitant. Based on the last Census Bureau reports, if Chicago invested in health to the same extent that Boston, New York, Newark and Washington did, its appropriations would be $1,460,000, $1,340,000, $1,316,000 and $1,005,000 respectively, whereas it spent last year only $723,000. In 1913 the health department cost Chicago 30.8 cents per capita; police, $2.86, and fire fighting, $1.43. The disparity is too great. The statistics indicate that the general awakening ten years ago to the increasing usefulness and possibilities of a properly equipped and financed health department in Chicago has not persisted. Ten of the largest cities in this country spend from 12.5 to 153.1 per cent more than Chicago does. May Dr. Young succeed in persuading the finance committee of the city council that the department's past allowances, when compared to other cities where preventable death rates are decreasing, have been too low.

Government Ownership Government ownership of railroads may soon become a national issue. It is reported that Senators Kenyon and Cummins of Iowa are preparing a bill authorizing an issue of 3 per cent bonds to buy all continental railroad lines for the Government. The hysteria which greeted a similar proposal by William Jennings Bryan several years ago is entirely absent now. To be sure, Mr. Bryan was at that time an aspirant for the Democratic presidential nomination, and we are much more excitable before a presidential election than we are afterward. The construction of the Panama Canal and the installation of the parcel post have apparently impressed the public that the Government has the ability to manage large undertakings. There is no doubt that stubborn opposition will be made to such a sweeping change in our economic conditions as is contemplated by the Iowa Senators, but many observers think that the present policy of government regulation of railroads must ultimately develop into Government ownership. President Ripley of the Santa Fé is quoted as saying: "Government ownership of railways is coming sure as fate. The legislatures hamper and cut our profits and the labor unions take what is left. We are practically between the devil and the deep blue sea." The railroads are finding difficulty in raising the money required to meet the demands of a rapidly growing population. Very large sums of money must be expended in the near future to provide increased terminal facilities and to increase the amount of double track. Railroad earnings are not now such as to attract investors, and the disclosures of the devious financial operations of the New Haven and of the St. Louis & San Francisco will probably do incalculable damage to the credit of all railways. The adverse public sentiment aroused by such scandals as these also make it difficult for Federal and State commissions to allow the railroads to make the increases in rates to which they are probably entitled. Regulation so far has meant a continual scaling down of rates, increase in wages and of rulings which increase operating expenses. It now remains to be seen whether the Interstate Commerce Commission will grant an increase in rates in the Eastern territory. We shall see whether regulation works both ways, thus assuring the continuation of private enterprise, or whether we must look to the Government for the management of all public utilities.

Model Utility Bill

In offering to the public last week its report on the public-utility law which it is framing the National Civic Federation outlined the principles upon which is based a work representing an expenditure of about $60,000. Drafted after a study of all the regulatory laws of the country, and based on correct views as to the protection of the rights of both public and investors, it will likely form an excellent basis not only for new legislation, where such a law has not been enacted, but also for amendment of existing statutes. The mere fact, however, that though the report was practically unanimous—there being only one dissenter—every member of the council objected to some feature of the bill indicates that there is ground for reasonable divergence of views. Consequently, changes are to be expected when the draft is used as a model for State enactments.

Among the main provisions are that the public utilities commission created by the bill may fix the rates and standards of service and may approve issues of stocks and bonds. A single commission is provided for all the utilities within the State, thus discouraging not only additional State commissions but also municipal regulation.

The bill strikes a blow at the graft which often marks the renewal of short-time grants by providing that the indeterminate franchise shall be used, with, of course, suitable safeguards as to forfeiture clauses and purchase by the municipality. Municipalities may either operate public utilities themselves or contract with private companies for their operation. In either event the utilities will be subject to the control of the State-utility commission.

While, therefore, final judgment cannot be passed until the bill is issued, the main provisions are along sane lines and can be heartily commended to the States. To expect any commonwealth to swallow the law as a whole would be to expect too much, but to urge, when issued, that it be given careful consideration as the basis for commission legislation, with a disposition to depart from it only on excellent grounds, is to accord the measure only that respect which the ability of its framers and the careful study given to it deserve.

Consolidation of the Highway Conventions

The holding of two important highway meetings within a few months necessarily tempts comparisons—and they were not wanting at the convention of the American Road Builders' Association in Philadelphia last week. The feeling was general that two sessions are uncalled for and wasteful, and that steps should be taken to bring about harmonious relations between the American Highway and the American Road Builders' associations, to the end that there shall be one national road congress each year. This is especially important when the Detroit and the Philadelphia meetings are considered. Each displayed strength in different ways. The road exhibit was superior at Philadelphia, but the meetings, outside of the spread-eagle oratory, were better at Detroit. The exhibitors last week were almost a unit in declaring that the visitors were buyers or prospective buyers—the sort of men that they desired to reach, and that this was true to a greater extent at Philadelphia than at Detroit. This was to be expected not only because the American Road Builders' Association is the older of the two but also because the date of the convention was timed better for the contractor. The Detroit convention, on the other hand, brought together more diversified interests—not only the contractors, who seemed to predominate at Philadelphia, and the engineers, who had a fair representation there, but also the road users and those whose chief interest in good roads lies in the legislative program. Nevertheless, the papers were largely a rehash of subjects covered at Detroit and at other road meetings. To be obliged to sit through such sessions twice within a few months is not sufficiently attractive to induce a man to make sacrifices to attend. Some public officials may not have strenuous objections, since for them it represents another "joy ride" at public expense.

The action of the Road Builders' Association, then, in adopting a resolution that there be but one congress should have the active support of all interested in highway work. If action is not taken, one or both of the meetings will suffer. Even at Philadelphia there was clear evidence that many engineers and contractors and some exhibitors have been forced to select one of the two meetings. Moreover, it was made clear by many who had attended both conventions that they would not do so in future but would go only to one. A majority of exhibitors, in fact, signed a petition calling for only one convention next year. It would be unfortunate if the incidents that preceded the Atlantic City road congress and its resulting personal feelings should stand in the way of effective publicity and educational work for highways. The way to get action is for all the members of the two associations to insist that a joint committee be appointed to discuss the matter. The interests are mutual, and unless plain stubbornness and lack of consideration for feelings and mistakes are allowed to stand in the way a satisfactory arrangement can be effected.

Hard and Soft Fillers

Cement fillers for brick and stone-block pavements will be forbidden on New York State highway work if the recommendation of the highway advisory board of the Department of Efficiency and Economy is adopted. This board, at the instance of the Governor, has reported to a special committee, consisting of the commissioner of highways, the attorney-general and the commissioner of efficiency and economy, on specifications covering the materials and methods of construction on all of the highway work of the State. A press account sent out by the Department of Efficiency and Economy last week states that "the brick or stone will be cemented together with an asphalt filler instead of cement, the claim being made that asphalt is more durable on account of its elasticity and is less noisy and much easier to repair." It will be noted that tar as well as cement filler is barred.

This is a flagrant disregard of engineering experience. To bar out by a wave of the hand what is conceded by highway and paving engineers as the most generally satisfactory filler is nothing short of folly. Without passing final judgment on the controversy between hard and soft fillers there can be no hesitancy in saying that the advocates of soft fillers have not proved their contention that it is superior to cement, except, possibly, under special conditions. The Office of Public Roads in a circular entitled "Vitrified Brick as a Paving Material for Country Roads" recommends cement filler "as better adapted for filling the joints in brick pavements than any other material which has commonly been used for that purpose." Moreover, in the same paragraph it is specifically stated that "bituminous fillers vary considerably in quality and efficiency, but all are more or less unsatisfactory." The National Paving Brick Manufacturers' Association in its standard specifications calls for a cement filler and is strongly opposed to the use of either asphalt or tar. Again, after a very careful investigation the controllers of wire-cut-lug brick have been so firmly convinced that a satisfactory pavement cannot be constructed with any other known filler than cement that they refuse to sell their product if a soft filler is to be used.

While these authorities, alone, should be sufficient to convince anyone that the cement filler is not to be idly dismissed, observation will lead to the same conclusion. While the use of the soft filler will be strongly defended by some engineers for certain locations and under certain conditions, the impartial investigator will, the Engineering Record feels certain, declare for cement for general use

The department gives as its reason for recommending asphalt that the material is more durable on account of its elasticity, that it is less noisy and much easier to repair. The claim as to greater durability when compared with cement is not borne out by the facts. It is true that it is less noisy, but this certainly is a minor consideration when brick is used for country roads. If State highways within cities are to be paved with brick that consideration enters, but even then it should be distinctly borne in mind that the noisiness of a brick pavement is not due chiefly to the blows of the horses' hoofs on the pavement but to the rattling of the wagon wheels over the unfilled joints. When the joints are filled flush with cement and the work has been properly done both brick and filler wear down so evenly that after a number of years the hand can be rubbed over the street surface without being able to detect when the fingers are touching brick and when the filler.

As to ease of repair, there is no question that the advantage lies on the side of the soft filler. As to this, however, there might well be argument, because the use of a cement grout would be a discouragement to the tearing up of pavements in order to take care of subsurface structures. Again, however, this objection has practically no force for roads in the open country, even if it deserves consideration when brick or stone is used on city streets.

In this discussion practically the entire attention has been given to the use of fillers for brick pavement. What applies to the brick applies equally as well, however, to stone block.

It is sincerely hoped, therefore, that the special committee composed of the commissioner of highways, the attorney-general and the commissioner of efficiency and economy, will reject the recommendations of the highway advisory board in this respect and not merely allow the use of cement fillers, but, taking advantage of the disinterested investigation of the United States Office of Public Roads, recommend its use in preference to other fillers. The latter recommendation is made by the Engineering Record with full confidence, for whatever the mitigating conditions may be that justify the consideration of soft fillers for city streets they are entirely absent on highway work in the country.

Colors of Artificial Lights

Under ordinary circumstances the color of the lights used for industrial purposes is not a matter of very great consequence, but now and then the character of the work is such that some attention must be given to the question of color. There is a large psychological factor in the matter, displaying a tendency to judge that any very bright light is approximating white in the absence of anything in particular with which to compare it. There is a slight basis for the belief, inasmuch as a light which, when weak, may show a considerable color, does for reasons connected with the theory of vision get whiter as the intensity increases.

A well-known German engineer has recently been making a very exhaustive study of the colors of the common sources of light which brings out some interesting facts. The first of these is that of the illuminants in present use none comes very near to daylight as that term is ordinarily understood. Daylight is a mixture of direct radiation from the sun and a considerable additional amount diffused from the blue sky or clouds. The latter component has been taken out of the sunlight as it filters through the atmosphere and is, in part, restored by the diffusion, the result being that ordinary daylight contains more blue and less red than sunlight by a very perceptible amount.

The only light which, unscreened, comes tolerably near the ordinary daylight is the Moore tube filled with CO_2, which is about 15 per cent short on red and about 8 per cent long on blue. Unfortunately it is as a source of light extremely inefficient, and various attempts have been made to use screens over sources like arc lamps, incandescent lamps and Welsbach burners to correct them to daylight color; but inasmuch as they are all weak in blue and the intensity of the other colors has to be greatly cut down to make them match, all such lights are in about the same class as the CO_2 tube in the matter of efficiency. A sunlight effect is easier to get, and a pretty close approximation is furnished by the magnetite arc lamp, which has too much red by less than 2 per cent and not enough blue by about 6 per cent. All the incandescent lamps —gas and electric—are a long way from white, having in general two or three times too much red and scarcely half enough blue for a proper balance. The arc lamps likewise are, generally speaking, rather far from being white, let alone a match for daylight, although very much nearer than any of the incandescents. The new nitrogen lamps occupy an intermediate position distinctly less near to white than the arcs and very much whiter than any previous incandescents. Finally, as freaks in the list, come the vapor lamps of various kinds—mercury arcs, Moore tubes, neon tubes, and so forth, of which only the one previously mentioned approximates white. The mercury lamp is a pretty good green, while the neon tube, the most eccentric of all in color, is almost a pure light red.

It must not be supposed that nearness to white, however, gives a just value of a lamp for illuminating purposes, because it is quite well known that nearly monochromatic lights, like the yellow flame arc, the mercury tube, and some others, really give very acute discrimination of detail in black and white, distinctly better than does daylight, and the last named is often reviled by the metal polisher on account of its really uncanny capacity for showing up spots which are not as they should be. But, altogether, the progress of artificial lighting shows better and more useful color values year by year.

Proposed Provincial Divisions of the Canadian Society of Civil Engineers

Organization could be developed to a far greater extent than at present among civil engineers in the West and the South with benefit to the individual engineers and to the profession at large. Membership in a national engineering society may be advantageous in various ways, but when the member locates in a city far removed from the headquarters of the society it affords him little opportunity to combine his influence with that of other engineers in the same State or district who may be interested in improving the professional status, giving voice to the attitude of the profession toward state legislation that concerns engineers, and securing for the profession generally the recognition which will be much more readily accorded to an organization than to an individual.

Both the American and the Canadian societies of civil engineers have established branches in many of the leading cities, which serve an excellent purpose by bringing together local members of the parent society. But they are limited in their activities chiefly to the reading and discussion of papers, and never represent more than the members resident in or near a single city. Never have municipal and government problems been of such importance to the engineer as at present, and any means whereby his influence can be strengthened deserves careful consideration.

A move toward better territorial organization, the outcome of which will be watched with interest on both sides of the international border, is the united action of the two British Columbia branches of the Canadian Society of Civil Engineers in asking for the formation of a provincial "division," whose primary object would be the building up of a strong organization by increasing the membership and uniting the influence of the members within the province. It was at first requested that this division be given power to pass on the qualifications of applicants for membership and to veto elections of undesirable candidates, that it receive a rebate from all annual dues collected in the province, that it elect its own officers and be given power to discipline members of the society resident within the province. The council of the parent society decided that no special privileges could be accorded British Columbia, but that an amendment to the by-laws of the parent society would be in order which would make possible the organization of provincial divisions throughout the Dominion. It was decided, however, that these divisions could not be allowed the power of disciplining members or vetoing applications. After some correspondence, two amendments were drawn up, one by the parent society and one by the British Columbia branches. These are now being submitted to the corporate membership for letter ballot, the results of which will be known Jan. 19, 1914.

The two branches of the society in which the movement originated readily submitted to the ruling of the council as to the powers which could not be granted, and the two amendments are the same in principle. The chief points of difference are (a) in the representation of the provincial corporate membership in the controlling body of the division; (b) the qualifications for the division chairmanship, and (c) the question of a $1 rebate to the division treasury from the yearly dues. The parent society proposes (a) two committee members from each branch within the province and an equal number of non-resident committee members. In the case of British Columbia this would, it is pointed out, give sixty non-residents the same representation as 160 branch residents, and this balance would be still worse in case a new branch should be inaugurated with the required ten corporate members, who would then have the same representation as the older and larger branches. The parent society would (b) limit the choice of chairman to members of the council of the parent body resident in the province, to which it is objected that these councillors might be men unable to take an active part in division affairs. In regard to the financial question (c) the parent body considered it incumbent upon the division to provide whatever funds are required for its own activities. The local members, on the other hand, hold that a successful division organization would result in sufficient increase in membership to more than cover the rebate asked, and, regardless of this, that the division should receive a part of the dues paid to the parent society on the same grounds that the branches are considered entitled to a rebate from the dues of each of their members.

The British Columbia members have shown a disposition to accede to the wishes of the parent council, but they feel that a division formed on the basis of the by-law prepared by the council will be practically useless. Western members of the Canadian Society of Civil Engineers themselves say that in western Canada membership in the society carries little weight, and the general interest in the new movement by the British Columbia membership shows that the present status is not entirely satisfactory. The code of professional ethics recently debated by the Pacific Northwest Society of Engineers and the activities of the Oregon Society of Engineers prove that the interest of Western engineers in professional organizations is not limited to the passive functions of presenting papers at local meetings and reading reports on what has been done at Eastern headquarters.

It is manifest that some sort of a division which will have a greater range of activity than the present branch would increase the influence of the parent society at the same time that it would afford the individual members a much-needed opportunity to have a voice in affairs of general interest to the profession. While the parent society does well to reserve certain powers which properly belong to the controlling body of the national organization, it might be well, nevertheless, to permit the formation of divisions with a sufficient range of power to make them effective in representing local interests. The division, under a good and sufficient plan of control, would be better for the individual than an independent organization, but if no encouragement or support is given in the formation of such divisions there will be a tendency to transfer activities to local organizations, in which the needs of the district and its professional men are better understood.

Designing Steel Pipe for Minimum Weight of Metal Consistent with Safety

Studies for the Jawbone Inverted Siphon of the Los Angeles Aqueduct, Which Operates under a Maximum Head of 850 Feet

By E. R. BOWEN
Assoc. M. Am. Soc. C. E., Los Angeles

THERE are twenty-one inverted siphons, totalling 11.4 miles in length, where the line of the Los Angeles Aqueduct crosses canyons and valleys. Eight of these siphons, comprising 2.7 miles, are 10-ft. reinforced-concrete pipes, operating under heads as great as 75 ft. The remaining siphons are steel pipes ranging in diameter from 7 ft. 6 in. to 11 ft. All have a capacity of 430 sec.-ft.

The Jawbone siphon, although not the longest or the greatest in diameter, operates under the greatest head. It is located near the center of the Jawbone division, 120 miles from Los Angeles, is 7096 ft. long, and operates under a maximum pressure of 365 lb. per square inch, or a maximum head of 850 ft. below the hydraulic gradient. The country is barren and dry and the canyon sides slope as much as 35 deg.

Factor of Safety

In locating the aqueduct, 26 ft. of grade were allowed for friction head in this siphon. The problem in designing this pipe was to attain the minimum weight of metal consistent with safety, using this total friction head. There is no shock or water hammer in a pressure pipe of this character, having a constant lead. It is built on piers and is, therefore, accessible for inspection and repair. Pipes laid above the ground deteriorate slower than when buried, especially in alkaline soil, and a factor of safety of 3 on the net section of the pipe was therefore decided upon.

Theoretically the most economical pipe in this instance would be a tapering one, the large diameter at the top, where there is no pressure, and the small diameter at the bottom, where the pressure is greatest. In practice this ideal condition cannot be realized, but it can be approached by using a large diameter pipe, reducing it in several places as the pipe goes down the hill and correspondingly increasing the size as it goes up the other side.

The location of the stations along the pipe at which these changes in diameter are to be made is a controlling element in the design and location. Clearly an infinite number of combinations of lengths of different diameters can be made, one of which will give a minimum weight to the entire siphon. The following graphical solution was evolved by Mr. E. A. Bayley, formerly locating engineer of the Los Angeles Aqueduct, and at present assistant engineer for the Department of Public Service, City of Los Angeles.

Minimum Weight of Siphon

Assume the same diameter pipe over the entire siphon and locate the pipe on the profile with regard to the safe heads on the various thicknesses of metal. Construct a diagram, platting the unit weights of the pipe as ordinates and the distance along the slant of the pipe from one end as abscissæ. The area under the curve will then be the total weight of the pipe. Plat a curve like this on the same diagram for each diameter of pipe likely to be used—in this instance 10 ft., 9½ ft., 9 ft., 8½ ft., 8 ft., 7½ ft. and 7 ft. We now have a series of curves, representing a like number of pipes, that are seen to be diverging as the pipe goes down the hill. The irregularities in the curves are due to the unequal slopes of the sides of the canyon. The problem is to obtain a combination of these pipes or curves that will give a minimum area under the curve of the combination for the friction head consumed.

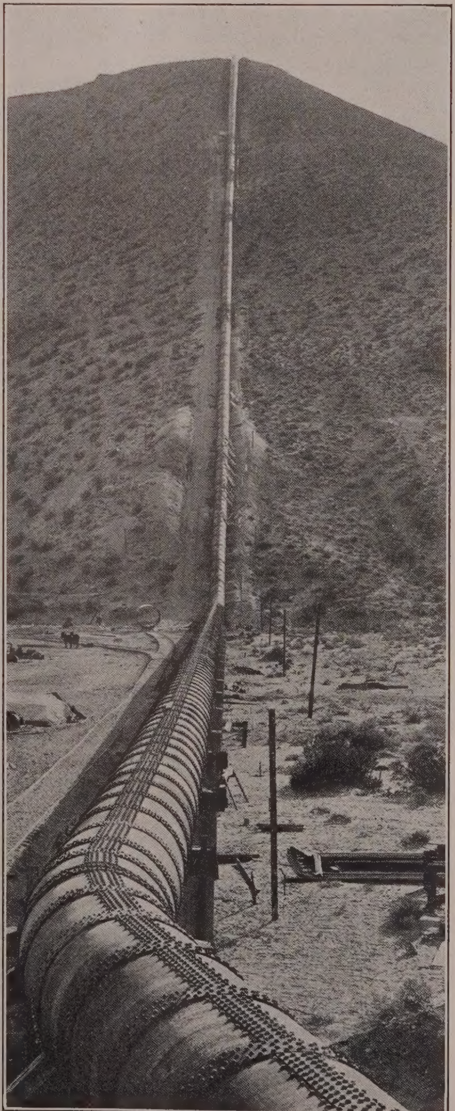
Compute the unit friction heads for each diameter of pipe used, the discharge, of course, being the same in each case. Prepare a table giving the diameter of pipe, the unit friction head, and the differences in the friction heads. This is done in Table 1 for the case in question, the friction head being computed for a discharge of 430 sec.-ft. and a value of C in the Chezy formula equal to 90.

Referring again to the diagram, assume a point a on the 10-ft. line for a change from 10 ft. to 9½ ft. in diameter. Then the point b for the change from 9½ ft. to 9 ft. in diameter must be so spaced along the 9½-ft. line that the ratio of the difference of the ordinates of the 10-ft. and the 9½-ft. lines at a to the difference of the ordinates of the 9½-ft. and the 9-ft. lines at b is the same as the ratio of the differences in their unit friction heads. That is, the difference of the unit weights of the pipes is proportional to the unit friction heads, calling the difference in ordinates at a, A, and at b, B: $A \div B = 0.000435 \div 0.000595$.

Follow this method through all the pipes used, locating the points c, d, e, and e', d', c', b' and a'. The intercepted ordinates $A' = A$, $B' = B$, $C' = C$, etc., and have the above ratio as: $B \div C = 0.000595 \div 0.00083$ and $C \div D = 0.00083 \div 0.000118$, etc. The area under the resulting curve will be a minimum for the friction head consumed in the pipes.

Table 1—Pipe Diameters and Corresponding Friction Heads

Diameter	Friction head per lin. ft.	Differences
10 ft. 0 in.	0.00148	
		0.000435
9 ft. 6 in.	0.001915	
		0.000595
9 ft. 0 in.	0.00251	
		0.00083
8 ft. 6 in.	0.00334	
		0.00118
8 ft. 0 in.	0.00452	
		0.00172
7 ft. 6 in.	0.00624	
		0.00258
7 ft. 0 in.	0.00882	
		0.00395
6 ft. 6 in.	0.01277	



Jawbone Siphon, Los Angeles Aqueduct

Graphical Solution

This rule may be proved graphically. Suppose we move the point c to m, a distance k. We have saved some friction head and increased the weight by the amount in the shaded area, using more 9-ft. pipe and less 8½-ft. pipe. The friction head saved is equal to the distance k multiplied by the difference in the unit friction heads of the 9-ft. pipe and the 8½-ft. pipe, or, calling this head h, $h = k \times 0.00083$. (See Table 1.) This head must be consumed in friction in order to make proper comparisons. If we move the point d to n a distance of k_1 we are using more 8-ft. pipe and less 8½-ft. pipe, and the weight of the composite pipe would be increased by the amount of the shaded area between these lines. The distance k_1 must be such that the friction head h gained in the first instance shall be consumed. Calling the additional head used here h_1 and following the same reasoning as above, $h_1 = k_1 \times 0.00118$. But h_1 must equal h. Substituting we have, $k \times 0.00083 = k_1 \times 0.00118$, or $k \div k_1 = 0.00118 \div 0.00083$.

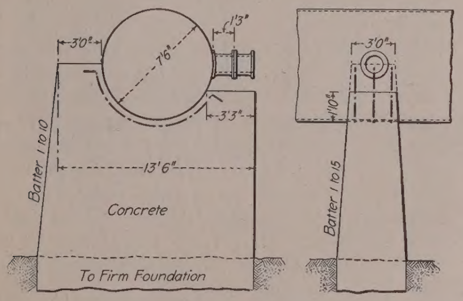
That is, the distance k is to the distance k_1 as the difference of the unit friction heads of the 8-ft. and the 8½-ft. pipes is to the difference of the unit friction heads of the 8½-ft. and 9-ft. pipes. These distances are inversely proportional to the differences of the unit friction heads, while the partial ordinates C and D are directly proportional to these differences. Therefore, these shaded areas would be equal if the lines were parallel, but in the case of the point c we have added an area between diverging lines and at the point c we have subtracted an area between converging lines, thus the net result would be to increase the weight of the composite pipe. The same result would be obtained if we moved the point c in the opposite direction.

The position of these points a, b, c, etc., such that a certain definite head be consumed in friction, may be arrived at by a few trials. Start with a definite length of 10-ft. pipe on one end and work through the location; compute the friction head consumed in this location, making proper deductions for loss of head at the points of change in diameter. Do this three or four times, starting with different lengths of 10-ft. pipe and plat a curve, with the lengths of 10-ft. pipe used as abscissæ and the corresponding total friction head as ordinates. Enter this curve with the desired friction head and obtain the initial length of 10-ft. pipe for the final location.

APPLICATION OF RESULTS TO JAWBONE SIPHON

The Jawbone siphon was designed and built in accordance with the results obtained from this study. The diameters range from 10 ft. at the ends to 7½ ft. in the center and the thickness of plates from ¼ to 1⅛ in. The saving in weight over a pipe of constant diameter, consuming the same head, was 298.4 tons, or 10 per cent. In a constant-diameter pipe the greatest thickness of metal would have been 1¼ in. The greater ease in working the thinner material in the compound pipe is also an advantage.

Specifications were issued covering all the fabricated steel and rivets for the Jawbone siphon, together with four other siphons, a total tonnage of 9555. Alternate bids were received on single-plate construction and two-plate construction, as it was thought that the two-plate construction might be less expensive, owing to the large plates required for the big pipes. In every instance, however, the bids were lower on the single-plate construction. Unusual or special specifications for steel plates were avoided in order that the lower prices of standard material could be obtained.



Special Piers under Blow-Off Valve

The specifications for chemical and physical properties of the metal were made to conform to the standard specifications of the American Society for Testing Materials, for boiler plate and rivet steel. Years of experience in the Los Angeles City Water Department have demonstrated that this class of steel is satisfactory for riveted steel pipe construction. The old charcoal iron has a longer life in the ground than the steel plates, but is practically out of the market. Some tests were made on the corrosion of pure iron plates, but it was found that while this class of iron would resist deterioration from acids better than steel in the alkalis such as are encountered in the southwestern soils of California it has no advantage, and the price was substantially higher.

PLATE CONNECTIONS

All plates over ½ in. had triple-riveted butt joints and were shop-riveted and joined together in two-ring sections, except the 1⅛-in. plate across the bottom of the canyon, which was riveted together in five-ring sections. Plates ½ in. or less in thickness had lap-joints with edges sheared for outside calking and were rolled and punched, all rivets being driven in the field.

With a long transcontinental haul, as was the case at Los Angeles, the question of the freight rates was an important element. By riveting the lighter plates in the field they could be nested as much as desired at the shop in order to obtain full carload weights. It would not have been possible to get full carloads had the pipes been riveted up in sections when shipped. With the heavier plates, where large rivets were necessary, as much shop riveting was done as possible.

Drawings were included in the specifications, showing the joint required for each thickness of plate, and the plan and profile of the pipe, giving its definite location as to line and grade. The contract was awarded to the Riter-Conley Manufacturing Company at a price of $29.40 per ton f. o. b. Pittsburgh.

Owing to the isolation of the construction work from any shop facilities, precaution was taken to eliminate possibilities of error. The successful bidder was required to submit to the office of the chief engineer detail drawings showing the proposed method of construction of all angles, transitions between butt and lap joints and typical transitions between different diameters of pipe, and thickness of plate, together with the regular straight section of pipe for all thicknesses of plate. In addition, diagrams of each siphon were furnished, drawn to a sufficiently large scale to show the exact positions of each section of pipe. These drawings were all carefully checked in the office of the chief engineer. It was required that all pieces be plainly marked in accordance with the diagrams to show their position in the completed pipe. The material was inspected at the shop before shipment, the metal analyzed and its physical properties tested. All dimensions and coincidence of rivet holes were checked by assembling. The result was satisfactory, as no errors were found.

CONSTRUCTION

Work was begun in January, 1912, with the installation of equipment, the excavation of the side-hill trench and for the piers. It was pursued to its completion in March, 1913.

The pipe is laid on concrete piers 2 ft. thick supporting one-quarter of the circumference of the pipe. The piers are spaced 36 ft., center to center, across the bottom of the canyon and closer on the hillsides. They are built on the bed rock on the hillsides and in the bottom of the canyon are carried down about 8 ft. into cemented gravel. The piers were built up to the sub-grade of the pipe and the reinforcement left projecting from the sides. The pipe was then built on these partly constructed piers and filled with water as soon as convenient. After the pipe had taken its proper shape the sides of the pier were cast. Before the pipe was filled with water there was a longitudinal expansion and contraction, due to temperature changes, and the resulting movement back and forth on the top of the pier was apt to check them on the edges. The piers would probably be better if they were armored with a thin sheet of metal so as to avoid this spalling.

Erection of the steel started in the bottom of the canyon, with the 1⅛-in. plate, and the pipe was extended up each side simultaneously. The steel was placed in position on the hillsides by a broad-gage rope haulage way, constructed alongside the pipe and operated by a 15-ton hoist, driven by electric motors.

In the bottom of the canyon the pipe was assembled in rings and rolled on to the cars. The pipe was chained to the car and the cable attached to the pipe. The cars were then drawn into position on the hillside with hoisting cables. When the pipe reached its position the chain was removed from the car and the pipe swung into place. The cable was released and the operation repeated.

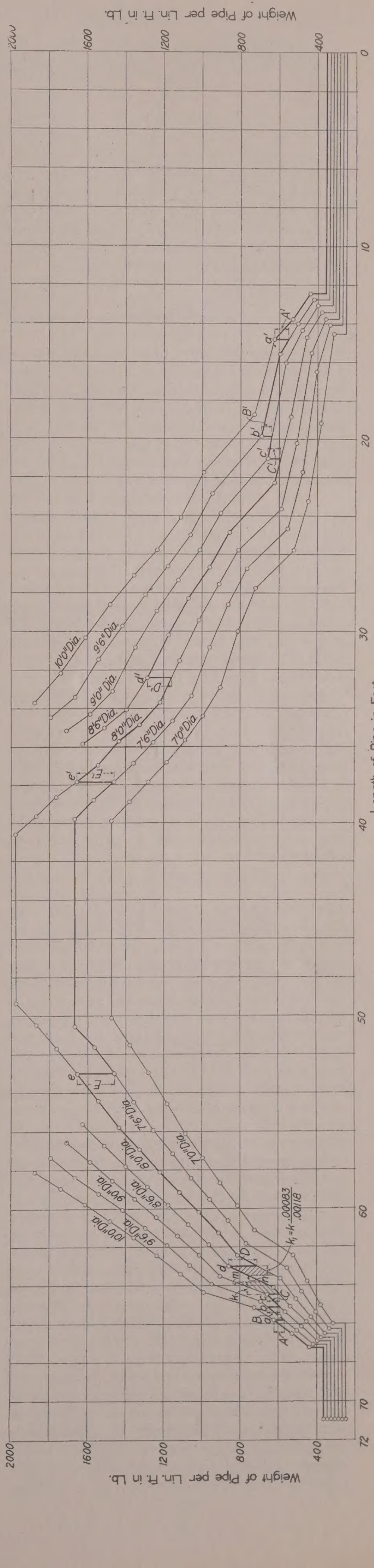
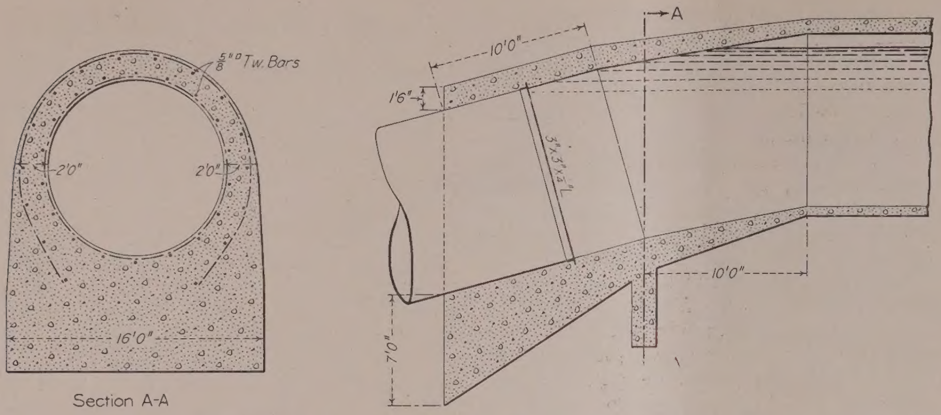


Diagram Showing Critical Points at Which It Is Economical to Change Diameter of Pipe on Jawbone Siphon, Los Angeles Aqueduct



Standard Transition for Steel Pipe at Junction with Concrete Pipe

The steel was shipped to Cinco, 4 miles from the siphon, and hauling was done by mules over sandy roads, with an average up-grade to the siphon of 1.65 per cent and short pieces with a maximum grade of 5 per cent.

The 1⅛-in. thick 7½-ft. pipe across the bottom of the canyon was shipped riveted together in five-ring sections, 36 ft. long, weighing about 26 tons. These sections had to be hauled on trucks with special steel wheels having 24-in. tires. The team consisted of fifty-two animals, six abreast at the wheel and twenty in the middle string, three freighters and two "swampers" at the brakes.

The hauling cost, during the time these large sections were handled, was $3.21 per foot of siphon, including loading. The cost of labor and livestock for hauling each section was $62.00. Loading from the cars at Cinco to the trucks cost 12 cents per hundredweight. Considerable trouble was encountered at first in unloading these five-ring sections, as they were shipped in gondola cars. This necessitated raising the sections with hydraulic jacks and cribbing to a height of 4 ft. above the bed of the car; whereas if they had been shipped in flat cars, as ordered, they could have been rolled to the platform at much less expense.

FIELD RIVETING

In field-riveting these heavy plates 1¼-in rivets were used and each rivet weighed about 5 lb. They were driven with the Thor and Boyer No. 90 air hammers, using air at 115 lb. pressure, furnished by an Ingersoll-Rand Imperial, type 10 compressor, driven by a 100-hp motor. The 1 1/16 x 4-in. pistons in the air hammers were replaced by 1 1/16 x 4½-in. pistons to give a harder blow. All rivet sets were made at the machine shop on the ground. A No. 60 Boyer hammer was used on the end of the air bucker inside the pipe.

After the hot rivet was put in the hole the bucker started the hammer inside and hit a few blows to put the rivet home; then the riveter started and both guns were kept going until the rivet was headed up. It was found that hammering on both ends of the rivet at the same time upset the rivet, drew the plates together and filled the hole much better than by using one hammer at the heading end only. The energy for this work cost 1.7 cents per kilowatt hour, and 1160 rivets 1¼ in. in diameter were driven during the month of May at a cost of 27 cents each.

The detail unit costs up to Jan. 31, 1913, are given in Table 2. All of the steel had been placed at this time and the work in February and March consisted chiefly of calking and painting. The costs as given are substantially correct, although subject to slight change when the accounts are cleared.

These are field construction costs only and do not include auxiliary expenses for roads, water supply and the multitude of minor expenses that make up a substantial portion of the total cost of building any large work which cannot be avoided. The equipment charge is subject to salvage credit. There were 191,785 rivets driven, ranging in diameter from ⅝ to 1¼ in., at an average cost of 8.8 cents.

TABLE 2—UNIT COSTS FOR STEEL PIPE SIPHON

Piers

Excavation, 163 piers, $23.41 each = $5.067 per cu. yd.
Concrete, 187 piers, 59.08 each = 8.57 per cu. yd.
Forms, 187 piers, 3.79 each = 0.55 per cu. yd.

Average cost per pier, $86.28 = $9.12 per cu. yd.
Average cost per foot of siphon for trenching, 65 cents.
Average cost per foot of siphon for piers and trench excavation, 7,096 ft. = $2.83.

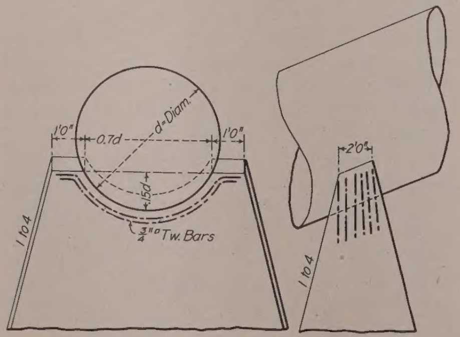
Pipe

	Lin. ft.	Cost per ft.	Cost per hundred-weight
Steel at Cinco	7,096	$21.80	$2.57
Unloading and handling	7,096	1.42	.17
Placing	7,096	2.45	.23
Riveting	7,096	2.52	.30
Calking	4,109	.90	.11
Painting	2,546	.65	.08
Equipment	7,096	3.66	.43
Superintendence	.....	.37	.04
Engineering	.....	.17	.02
Blow-off proportion	.....	.06	...
Average cost		$34.00	$3.95
Average cost per foot of siphon for piers and trench excavation		2.83	
Total average cost		$36.83 per ft.	

The riveting crew consisted of four men—a riveter at $4.00 per day, a heater at $3.00, a bucker at $2.75 and a sticker at $2.50, the names being descriptive of their respective duties.

BONUS SYSTEM FOR RIVETING

On the other siphons on this division the riveting was done under the bonus system, the schedule for which is shown in Table 3. Because of the care necessary in driving the large rivets, erecting the pipe on the steep hillsides, and the necessity of having the riveting done in the most careful and efficient manner on the pipe under high heads, it was decided not to employ the bonus system on the Jawbone siphon, an increase of 50 cents in the per diem rate of the riveter being made in lieu of this. This arrangement proved very satisfactory.



Standard Piers for Steel Pipe

The rules covering the payment for bonus were as follows: Ten days shall constitute a bonus period. The first period shall be from the first to the tenth of the month, inclusive; the second from the eleventh to the twentieth, inclusive; and the third from the twenty-first to the end of the month. Bonus payments shall be allowed upon the basis of measurements made at the close of each ten-day period.

Only men who work continuously through the ten-day period, with the following exceptions, shall be entitled to bonus: (a) Any employee entitled to bonus earnings who is injured or becomes ill during a period from conditions arising directly from siphon construction shall participate in bonus in proportion to the number of shifts worked by him during said period. (b) If any employee entitled to bonus earnings is transferred during a period to another part of the work for reasons other than his own request he shall participate in bonus in proportion to the number of shifts worked by him on such construction. (c) If the work is interrupted by the failure of power, shortage of material or supplies, or other causes beyond the control of the men, the men shall be entitled to bonus in proportion to the number of shifts worked by them during the period in which such interruptions occurred.

TABLE 3—BONUS SCHEDULE FOR SIPHON WORK ON DIVISION 8-A

Mechanic employed as	No. of men per shift	Size of rivets, in.	Wages per diem.	Base rate per shift rivets	Crew bonus per rivet	Bonus per man per shift, per cent
Riveter	1	⅝	$3.50	500	$0.01½	30
		¾		400	.01¾	
		⅞		325	.02	
		1		275	.02¼	
Heater	1	⅝	3.00	500	.01½	30
		¾		400	.01¾	
		⅞		325	.02	
		1		275	.02¼	
Bucker	1	⅝	2.75	500	.01½	20
		¾		400	.01¾	
		⅞		325	.02	
		1		275	.02¼	
Sticker	1	⅝	2.50	500	.01½	20
		¾		400	.01¾	
		⅞		325	.02	
		1		275	.02¼	

PIPE COATING

A large variety of paints and protection coatings were investigated. It was found that in the use of lead paints all the rust scale must be carefully removed, as the paint would not penetrate it, but would fleck off, leaving the rust spot beneath. The paint used was a residual hydrocarbon oil, resulting from the manufacture of gas from California asphalt oil. It is different from the Eastern coal tars and has the distinct property of penetrating rust and rust scale on the metal. Experience gained from years of its use on steel pipe in California demonstrates the long duration of this paint as a protective medium. During cold weather, or when put on cold plates, it became necessary to heat this oil tar and dilute it with distillate, but with warm conditions dilution was unnecessary. It was applied to the pipe with brushes. All the steel work on the aqueduct is painted with this material. Its cheapness is another distinct feature, as it cost but $4.00 per barrel of 50 gal. and 1 gal. covered about 400 sq. ft. with one coat. The cost of painting with two coats varied from ¼ cent per square foot, under the most favorable conditions, to 1¼ cents per square foot, under the most unfavorable conditions.

The pipe is completed and has been filled with water for five months. There is no leakage worthy of mention, the joints all being tight, including those under the highest heads. It is worthy of mention that the field work is as tight or tighter than the shop joints, which were riveted by hydraulic riveters.

CALKING

An interesting point in the construction is the connection where the circular butt-strap joins the two longitudinal straps over the ends of the main sheet. In cases where the ends of the main sheet did not meet, the openings were filled with litharge and glycerine and plugged with a soft steel wedge, calked in. There has been no leakage at these points.

No expansion joints were used in any portion of the siphon. There was movement in the pipe during construction, due to temperature changes, but this largely stopped when the pipe was filled with water. The ends of the pipe are rigidly held by massive concrete anchorages at the transition sections from the conduit adjoining. Angle irons were riveted around the outside of the end plates and the concrete anchorage was cast over the pipe for a distance of about 10 ft. This concrete was cast after the pipe had been filled with water, and during cool weather, the effort being made to make the casting when the pipe was in a condition of minimum length. All of these joints have stood well, no rupture of the concrete has occurred and at a recent inspection there was not a hair crack where the steel joins the concrete. No buckling has occurred after the pipe was filled and no rivets have been found to have been sheared by expansion or contraction of the pipe.

The work was done under the supervision of Mr. William Mulholland, chief engineer, and Mr. J. B. Lippincott, assistant chief engineer, with Mr. H. A. Van Norman, division engineer, in direct charge.

White Star Dock

The White Star dock at Southampton, England, is a 400 x 1700-ft. tidal basin 40 ft. deep below low water, with quay walls carried down to the mud and sand to a maximum depth of 73 ft. by open trench and caisson construction, after which the basin was excavated by ladder dredges, as described by Mr. S. C. Wentworth-Sheilds in a paper before the Institution of Civil Engineers. The mud bottom of the basin, which was covered at high tide and exposed at low tide, had been nearly surrounded by a chalk bank through which excavation for the wall trenches was made in the dry to a depth of 30 to 45 ft. Below this level work was completed to a depth of 72 ft. in timbered trenches. In one section where the bottom blew up the foundations were sunk by reinforced-concrete dredged caissons on which the lower part of the wall was built partly with mass concrete and partly with concrete blocks set by divers. A portion of the dock was outside the inclosing bank and the two quay walls were constructed entirely under water by helmet divers. Mass concrete was deposited under water in the bottom of the trench between face walls; 6 and 8-ton concrete blocks were used. At the south end of the dock, near the inclosing banks, the trenches were sunk from the surface to a deptth of more than 70 ft. in 100-ft. lengths.

State and Federal Co-operation in Irrigation Work

How $100,000, Jointly Subscribed, Is to Be Spent in Order to Realize the Fullest Benefits from Development of Natural Resources

By E. G. HOPSON

Supervising Engineer, U. S. Reclamation Service, Portland, Oregon

TWO projects involving the co-operation of the State and Federal Governments have recently been initiated in Oregon, and one, involving co-operation between an association of private individuals and the Federal Government, looking to ultimate co-operation between the Government and the State, has been started in California, and because of its commendable features such joint work warrants the careful consideration of engineers.

During last spring a contract was drawn up between the U. S. Reclamation Service and the State of Oregon providing for co-operative work between these parties. The movement toward co-operation was initiated by some of the leading citizens of the State during 1912, when a memorial was submitted to the Secretary of the Interior showing that the State of Oregon had large resources undeveloped and in many cases artificially tied up and withheld from utilization. It was requested that the Interior Department agree to set aside the sum of $50,000 provided the State would set aside a similar sum, the entire amount to be used in surveys and investigations covering a large part of the arid portion of the State, the result of which would be that both State and nation would have an intimate knowledge of the situation and be able to act with wisdom in their future disposition of these resources. The Secretary of the Interior promised to co-operate with the State as requested.

The Legislature of Oregon in the spring of 1913 passed an act appropriating $50,000 to be used in the manner outlined in the original petition to the Secretary of the Interior. The Secretary of the Interior thereupon definitely allotted the sum of $50,000, thus making a total fund of $100,000. A formal contract between the nation and the State was then executed, and operations thereunder were commenced in the early summer.

COLLECTION OF DATA

Several parties of engineers have been engaged for the last four months in central Oregon under this contract. A great deal of wash and diamond drill work has also been carried out at various dam sites. Much data from detached surveys and investigations made by both State and Government in previous years and by private parties from time to time are also being co-ordinated and used wherever they are available. All of the work is being carried out by the Reclamation Service, following an agreement with the State authorities as to a general plan of operation. The purpose in view is to reach an ultimate decision on the result of these surveys as to reasonable policies to be followed in development work in the various districts under consideration, so that the State, in its disposition of the public waters, and the Government, in its disposition of the public lands, will act in accord with each other and with a carefully devised plan to the end that the greatest possible good will be achieved.

To illustrate what I mean in this connection: What the co-operative plan is endeavoring to avoid is the wasteful and selfish development that one so frequently sees in different parts of the Western country, where individuals or corporations make partial developments in such manner as to practically prohibit the further utilization of other large resources of land and water in the vicinity. The common custom is for each project to be built independently and regardless of full utilization of the natural resources of the locality, with the result that great waste or needless expense is caused. The co-operative plan between the State and the Government works on exactly opposite principles, it being the idea to ascertain the extent and character of the natural resources of land and water in each locality, the most advantageous way of utilizing them for the benefit of the public as a whole, and lastly the establishment of a definite plan, approved by both governments, by which subsequent development, whether by State, Government or private interests, will be brought into conformity with the larger plans that have been adopted.

The work now in progress is making substantial headway. It is hardly to be expected that definite decisions on such momentous questions can be reached in the early stages, and it probably will be well into 1914 before plans for developing the great Deschutes basin, or other large basins, like the John Day, can be definitely agreed upon by both parties.

No actual construction operations to be shared in jointly by the State and nation have yet been agreed upon, although it is reasonable to expect that such will follow a favorable report. A great deal, in fact, has already been accomplished even in this direction, as the Secretary of the Interior has informally expressed his intention to co-operate with the State in actual construction enterprises under this plan at the proper time. It may, therefore, be regarded with confidence that the present co-operative investigations will ripen in due course into practical results of a far-reaching character.

ADVANTAGES OF CO-OPERATION

The advantages of such co-operation are clearly manifest. By the present system under which the Reclamation Service is operating all of the cost of the work in the several projects of the Service has been borne by the Federal Government. It will be readily understood that such operations, even though of a beneficent character, being directed from so distant a center as the capital, do not give the fullest satisfaction in the several localities, one reason being that, no matter how closely the Government tries to harmonize its system and plans to local requirements and idiosyncrasies, it is always to a certain extent in the position of an outside benefactor and its motives are subject to misconstruction and misunderstanding.

The principle of co-operation, in which all parties share the expense and the business risk of each enterprise, and also share to a considerable extent the direction and general responsibility, is an extremely wholesome one, and in order to achieve the fullest success it is my belief, and I think that of many others, that this principle must be injected into much of the work of the Government under the Reclamation Act. As a practical matter co-operation is also desirable in enlarging the powers of the field organization. The legal powers of the Federal Government in field operation and administration are extremely limited; the powers of the several States are, on the other hand, practically unlimited. It is practically impossible for the Federal Government to coerce a recalcitrant minority of landowners into a scheme of vast benefit; the State, on the other hand, can do this, and a combination of the two powers seems to be of high importance in achieving best results in disposing of the public waters and the public lands, and of dispensing proper police regulation and laws in the matter of upkeep and operation.

Another instance of co-operation has just been started in Northern California. There is an irrigation project in the Sacramento Valley known as the Iron Canyon project, comprising about 200,000 to 250,000 acres of excellent land that can advantageously be watered from the Sacramento River. The cost of construction is admittedly high, and the project is complicated by considerations of preserving the navigability of the Sacramento River, as well as by a very difficult engineering problem in dam construction. The Reclamation Service has during the last ten or twelve years been urged from time to time to take up this project as a regular reclamation project. This has been entirely infeasible for many reasons, the chief reason being that funds were not available for so large an undertaking, involving an expenditure of more than $15,000,000.

During the last few months residents and landowners within this project have combined and subscribed to a fund, and have requested the Secretary of the Interior to contribute a like amount, and expend the entire sum in surveys, investigations and other work that will demonstrate the feasibility and the most practical way to achieve the end desired. It is understood that a very widespread measure of co-operation in construction will alone render this project feasible. The project involves not only the reclamation of arid lands but the improvement of navigation on the Sacramento River, the development of some 50,000 or 60,000 hp of electrical energy and a large measure of relief from floods to the low lands in the Sacramento Valley.

BENEFICIARIES OF PROJECT

The door is thus open to co-operation among the following parties: Irrigation districts organized under the State law; the State of California in connection with water-power development; reclamation districts in the Sacramento Valley in connection with flood prevention; the War Department of the United States in connection with navigability of the river, and the Reclamation Service of the United States.

The desire of the landowners and residents of the project is to have a definite plan outlined by the United States which will permit all of the above agencies, and possibly others, to co-ordinate themselves in some practical manner whereby each interest will secure a maximum benefit at a minimum cost and a work of great public value will be accomplished. It is, in short, an attempt to create order out of disorder and disunion.

The contract between the Interior Department and the local association was signed Oct. 6, and active operations are now in progress. The work is being done by the Federal engineers, who have agreed not only to complete all preliminary field work but, if the work be found feasible, to block out a practical plan whereby the great interests involved may co-operate in a worthy construction program.

The most recent co-operative enterprise is the investigation of an importnt power project on the Columbia River about 100 miles east of Portland, Ore. There is at this point a great basaltic formation, through which the river has cut a deep, tortuous channel and flows in a series of rapids. A navigation canal around these rapids has been under construction by the Federal Government for several years, the work being known as the Celilo Canal. It is believed that a dam can be built in the Columbia River at the head of the rapids which will develop a considerable power head. When it is recollected that the minimum flow of the Columbia is more than 50,000 sec.-ft., with a maximum considerably exceeding 1,000,000 sec.-ft., it will be readily understood how large power can be developed if dam construction prove feasible.

The State has made an appropriation and appointed a commission to handle the necessary investigations, and on request of the State the Secretary of the Interior has made an allotment of an equal amount and has appointed a board of consulting engineers, of which the writer is one, to co-operate with the State in handling this enterprise. It is believed that the large power that may be developed at this point will be of importance in future irrigation works along the Columbia River and at other points where gravity supplies are not available. A contract between the State and the Government has not yet been drawn up, but is in course of preparation.

The co-operative movement to-day is comparatively young, and there are no definite and important construction results to record. It is, of course, possible that it will be many years before there is complete fruition on these lines, but the tendency is a healthy one and one that will be watched with great interest.

Railway Electrification a Conserver of Natural Resources

Suggestions as to the Unrealized Possibilities of the Wholesale Transmission of Electricity for the Railroads

RAILWAY electrification is usually discussed either from the viewpoint of the railroad man who wants to be shown in dollars and cents how it will profit his company to change from steam operation, or from that of the electrical engineer, who accepts electrification as inevitable and devotes himself to comparisons of the various systems. The matter is looked at from a different angle by Mr. G. Percy Cole, M. Am. Inst. E. E., electrical engineer of the Canadian General Electric Company, Ltd., of Toronto; in a paper read recently before the Canadian Railway Club he bases his plea for electrification on the arguments that the steam locomotive is a great consumer of the world's store of energy in coal, that the country (Canada) abounds in undeveloped water powers, and that the transmission of electricity on a large scale for the railroads would open the way to a much more efficient use of natural resources. These notes are taken from his paper.

Notwithstanding all our great hydroelectric developments, a large part of our power supply is still obtained from the energy of coal. Much labor is used in mining and distributing the coal, in cleaning up the dirt produced by its use, and in the actual operation of burning it. Taking all the uses of coal into consideration, it has been shown that we are getting back much less thaan 10 per cent of the latent energy in the fuel. The fact that we are throwing away more than 90 per cent of the value of our coal in the process of conversion is a matter for serious consideration.

GENERAL USE OF ELECTRICITY

Undoubtedly the most convenient method of utilizing energy is by means of electricity. It must be remembered, however, that the distribution of energy in the form of electricity instead of coal can only be effectively carried out when it can be done in such a way that it is available for all the purposes for which coal is now used. In order to supply electricity for all purposes, it has been shown that it would be necessary to have a conversion efficiency (from coal energy to electric energy) of not less than 25 per cent. On the basis of large generating stations of 250,000-kw capacity at the pit's mouth of the coal centers supplying net works of high-tension transmission lines with a load factor of 60 per cent it has been estimated that the average price at which the current could be supplied throughout the country would be ¼ cent per kilowatt-hour.

Electricity cannot as yet be bought for the above low figure. The Great Falls Power Company has, however, made a rate of 0.536 cents per kilowatt hour to the Chicago, Milwaukee & St. Paul Railway. If power can be obtained from the large central stations at such reasonable rates, it will not be justifiable for the steam roads, undertaking electrification, to go to the great expense of constructing their own power houses.

RELATIVE EFFICIENCY

In whatever form energy is produced and distributed to the train, it ultimately appears as mechanical energy applied to turn one or more axles against the resistance to their rotation imposed by the weight on the wheels and the motion of the train. It is instructive to examine and compare the over-all efficiency from coal pile to driving wheels for electric and steam operation. Taking first the conversion efficiencies for electric generating stations, we find the following:

Electric generators driven by reciprocating steam engines, their economy expressed in the form of efficiency in the coal to electric energy, may be taken as having a maximum of 10 or 12 per cent. Steam-turbine driven generators have a maximum efficiency of 17 per cent. Next in order of economy comes the large gas engine fed from gas producers, with an efficiency of possibly 25 per cent. Finally, the internal combustion engine using crude petroleum (Diesel type) direct connected to the electric generator has the maximum efficiency in the neighborhood of 30 or 31½ per cent.

The above figures all apply to the largest power stations at present in existence and the efficiency is the "power" efficiency of the station at full load and unity power factor. These figures will be very much reduced when we consider the annual over-all efficiency, taking into account all the varying conditions of output during the year. For the steam-turbine plant, which a detailed analysis will show to be the only one feasible for a station of large output, an annual efficiency of 11 per cent may be considered very good. Taking into account the transmission, substation and locomotive losses, this is reduced to 6 or 6.5 per cent for the ordinary heavy passenger train.

Comparing this with a 185-ton Pacific-type steam locomotive, the steam locomotive has been estimated to give a net efficiency from coal to drawbar of approximately 2.65 per cent with a similar train. This shows that the electric locomotive requires less than half the amount of coal needed by the steam locomotive. Expressed in another way this means a consumption of 0.163 lb. of coal per ton-mile for the steam train and 0.077 lb. for the electric train. This is significant in view of the estimated consumption by the railroads of more than one-fifth of all the coal mined.

Choice of System

There is no one system in electric operation that meets all the varied demands of railroad operation. Four systems are furnished by the present state of the art, as follows: (1) The low-pressure direct-current system, working at from 500 to 600 volts; (2) the high-pressure direct-current system, working at from 1200 to 3000 volts; (3) the single-phase alternating system, and (4) the polyphase alternating system.

System 1 has abundantly proved its applicability for electric urban traction and short urban or interurban railway lines all over the world. The low voltage employed limits the economical use to a few miles, unless coupled with the employment of rotary converter substations. System 4 finds its greatest application for mountain-grade divisions and tunnels with heavy grades; as it is possible to introduce great economies in operation, due to being able to connect the motors as generators and return power to the line when going downgrade. System 2, while the last to enter the field, is, in the opinion of many, the solution for trunk-line electrification. It is certain that the capital cost of rolling stock will not be appreciably greater than that of the low-tension continuous-current rolling stock, and that a very high efficiency of transmission will be obtained between the power station and the train. System 3 has the advantage of being able to transmit and pick up current from overhead trolley wire at high voltage and transform down on the locomotive to low voltage.

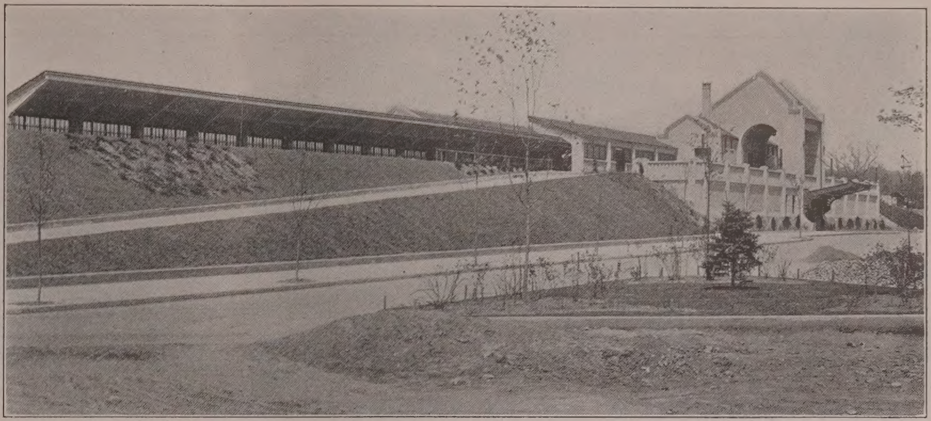
Indirect Advantages

The large water powers with which Canada is endowed should aid in electrification, since large quantities of cheap energy are available in various parts of the country. Numerous indirect advantages might accrue from electrification. If the railroad purchases large blocks of power at low figures from the central-station supply companies at the large centers, it will be able to utilize a portion of this energy for operation of its railroad shops.

As the high-tension transmission lines will in all probability travel along the right-of-way of the railroad, taps can be taken off from these lines and power sold to advantage to small towns or large farms and ranches. Inexpensive step-down apparatus has lately been developed, enabling even small quantities of power to be tapped off high-voltage lines.

In the great wheat belts of Canada the power could be sold to do the threshing and perhaps, in the future, to increase the yield per acre, due to the direct stimulation of plant growth by means of electricity. Experiments in England have shown an increase in the yield per acre of from 15 to 50 per cent, due to a proper application of high-tension currents. In California it has also been shown that an electrified field in which sheep are grazing has largely increased the yield of wool and improved the quality at the same time.

The adoption of electricity as a motive power for all manufacturing operations would mean an immense conservation of the labor of the nation. This would have a tendency to make labor more remunerative, which in turn would stimulate invention in all kinds of labor-saving devices.


View of New Station, Canopies and Approaches at Bloomfield

Bridges, Stations and Masonry Work on the Montclair Branch Improvements

Artistic Treatment of Concrete and Other Structural Materials on This Suburban Line of the Delaware, Lackawanna & Western

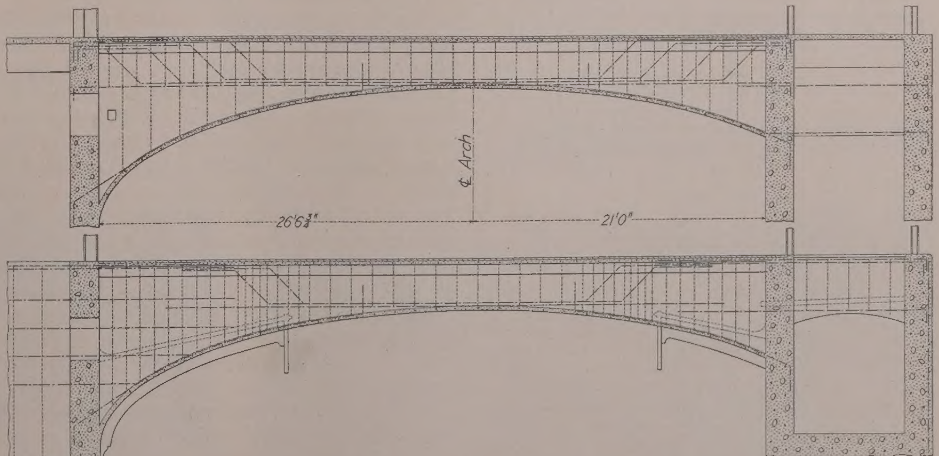
PRIMARILY the Montclair Branch improvements of the Delaware, Lackawanna & Western Railroad were to eliminate grade crossing and provide an adequate terminal at Montclair. Throughout the work, however, efforts were bent to get away from the ugly steel bridge and the monotonous and soon discolored plain retaining wall so often used in such work, and combine pleasing effects with structural requirements. Of bridges there are arches, flat-topped reinforced-concrete structures, and those of the ordinary plate-girder type encased in concrete; but in each case, except at two or three streets of lesser importance, whatever steel was used is concealed, and the work of the architect was called into play, as the illustrations show. Each of the four stations, including the terminal at Montclair, described in the issue of Nov. 1, 1913, page 495, and the remodeled station at Glen Ridge, is distinctive, even to the canopies.

The general improvement is about 3 miles long, extending from a point north of Ampére station to the end of the branch at Montclair. It is located in three municipalities—Bloomfield, Glen Ridge and Montclair—the fourth station, Watsessing Avenue, being in Bloomfield. Before the work was started the grades were heavy, especially from Bloomfield up to Montclair, but on account of the shortness of the branch and the probability of electrification in the not-distant future it was deemed inadvisable to attempt to lighten them except insofar as it would facilitate the elimination of the grade crossings.

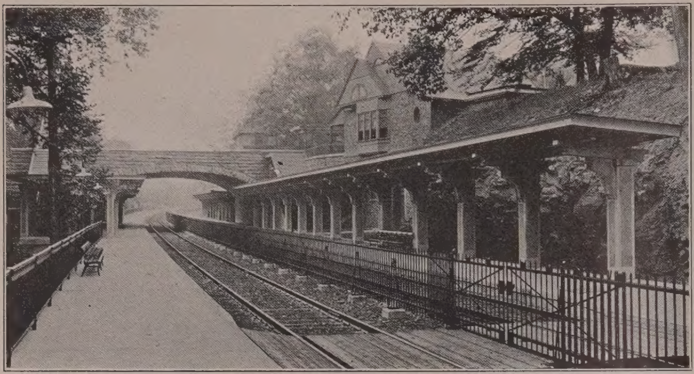
General Outline of Work

Beginning a sufficient distance east of the Arlington Avenue crossing, the tracks are depressed and carried under four streets and the Erie Railroad. Between Watsessing and Bloomfield the new profile crosses the old, and the tracks are elevated over the two streets at Bloomfield station, Glenwood Avenue and Washington Street, the fill being made mostly from the solid rock taken from the Watsessing cut. Here at Bloomfield is the only radical change of alignment on the work, the tracks being moved to the south about 100 ft. to ease a bad curve and give more room for the new station grounds and local freight yard.

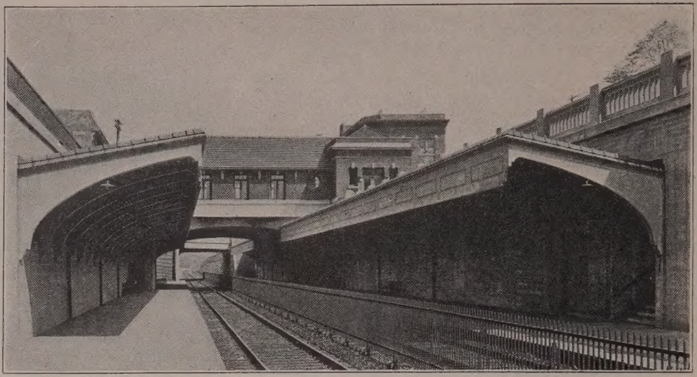
At Washington Street, where the tracks are elevated about 18 ft., the heavy grade up to Montclair begins. Clark Street, which was carried under the old track by a very narrow subway, has been widened out, the raising of the tracks permitting the use of a deck bridge, one of the three plain steel bridges on the work. At Hillside Avenue the change of elevation is approximately 8 ft., and the old grade crossing is replaced by an undercrossing. The new profile gives a short stretch practically level at Glen Ridge station to make it easier for trains to start; and just west of the station the tracks get down to the old grade, as there were no grade crossings in



Rod Arrangement in Girders Carrying Watsessing Avenue Station



Station Platforms and Stone-Faced Arch at Glen Ridge



Canopies and Overhead Station at Watsessing Avenue

Glen Ridge west of the station. The elimination of the four grade crossings in Montclair has been described in previous articles.

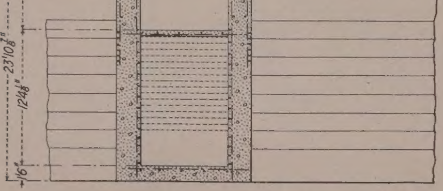
GLEN RIDGE CHANGES

At Glen Ridge the old single track was confined closely by Toney's Brook on one side and the face of a rock cut on the other. There was only a short, narrow platform, the cobblestone station building being up on the street (Ridgewood Avenue), which was carried over the track by an unsightly steel I-beam bridge with brownstone abutments. A steep stairway led from the platform to the street.

In the new work the solid rock was taken out on one side and a retaining wall was built along the creek on the other. The overhead bridge was replaced by an arch spanning the two tracks and the extended platform. This arch is of concrete, but is faced with the brownstone removed from the old abutments, giving the appearance of an all-stone arch. Three new stairways were built and the new walls next to the station were faced with cobblestones to conform with the construction of the station building.

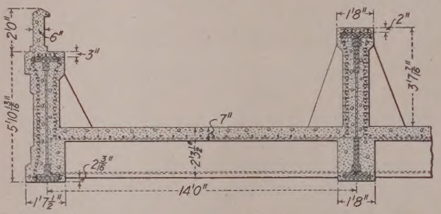
With the old profile there was a stiff ascending grade all the way from Bloomfield to Montclair. Elevating the tracks at Bloomfield made it possible, as already stated, to insert a practically level stretch at Glen Ridge station to facilitate starting trains, the old grade being reached at that point. This change at the same time raised the tracks 8 ft. at the Hillside Avenue crossing, this avenue being carried under the bridge shown. The bridge is a three-span steel structure of ordinary design, encased entirely in concrete, and with a concrete floor. Still another crossing in Glen Ridge, the underpass at Clark Street previously mentioned, was changed.

The Bloomfield improvement, the early stages of which were described in the Engineering Record of June 10, 1911, page 636, divides naturally into two parts—the track elevation near the Bloomfield station and the Watsessing depression. The work at Bloomfield proper includes a shift of the tracks to the south about 100 ft., the construction of a new station, the building of a new street in front of the station, and the elimination of the Washington Street and Glenwood Avenue grade crossings on either side.



Stairway Details at Washington Avenue

The Washington Street and Glenwood Avenue bridges are similar in appearance. Both differ from the Hillside Avenue bridge in that the curb-line piers are of reinforced concrete and the spans over the sidewalks are reinforced-concrete slabs, only the center spans being of steel. In the case of the Hillside Avenue bridge there was no change of alignment and it was necessary to raise the single track on its existing line and get the new bridge into service as soon as possible. This was possible with the all-steel design, the concrete casing being placed afterward. At the two Bloomfield bridges, on the other hand, the old alignment, some distance north of the new alignment, permitted the slower progress obtainable with the use of more concrete, the tracks on the old alignment being kept in use until the bridges had been built and the concrete had properly set.



Concrete Incasement for Steel Girders

WASHINGTON STREET STAIRWAY

The Washington Street bridge was designed for a third track to serve industrial sites, but after the abutments and piers were in place the town changed its plans and decided not to have the siding. Meanwhile a stairway had been built up through the east abutment to the station platform. Details of this stairway are shown. The stairway well consists of two longitudinal reinforced walls connected by two transverse walls, one of full height at the end and the other under the intermediate landing platform. Below the landing level these walls, together with the bridge abutments, act as counterforts, and the wall was reinforced between these in a longitudinal direction to take the lateral pressures.

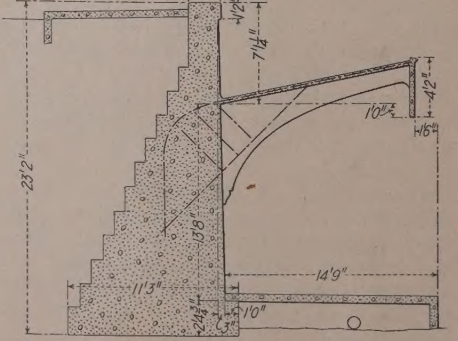
Above the landing level the longitudinal walls were reinforced vertically as cantilevers to resist lateral pressures. For a depth of 3 ft. immediately below the landing level these longitudinal walls were designed as a reinforced beam to take the reaction of the cantilever in addition to the side pressure. The bottom slab serves as an additional tie and a spread footing. There is no fill on the inside of the well.

The location of the Washington Street and Glenwood Avenue crossings and the moving of the tracks south lent themselves to the distinctive treatment of station and grounds at Bloomfield station, with the 15-ft. incline drive at each end, the high-level carriage terrace, the waiting room on the opposite side, and the reinforced-concrete platform canopies with wide overhang firmly anchored at the bottom of the embankment. The newly constructed street in front of the station is in the approximate location of the old tracks.

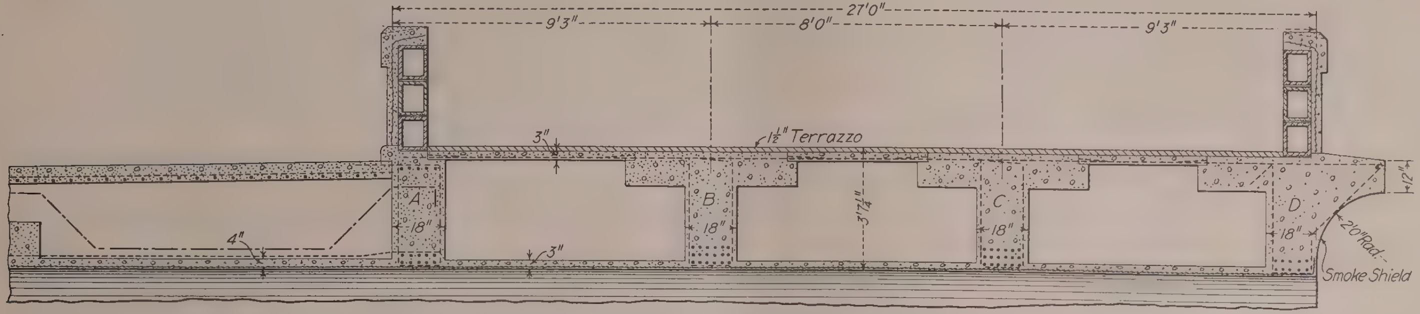
WATSESSING DEPRESSION

Through the Watsessing depression the right-of-way is so narrow that retaining walls were required for almost the entire length of 0.9 mile. These walls are of gravity section, with a uniform batter of 3 in. irrespective of the height, in order to give straight copings. Both battered and stepped backs were used, but the former were found more satisfactory, requiring less of both material and labor. Drainage was taken care of by means of blind drains of loose stone every 20 ft. behind the walls for their full height, with a weep hole opposite each drain. The walls were built without horizontal joints, usually in 20-ft. sections. In the vicinity of Watsessing station special care was taken to give the walls as pleasing an appearance as possible by topping them with artistic balustrades of reinforced concrete. An underground conduit was built the full length of the cut to take care of all wires.

The most westerly crossing of the depression is that of Orange Street. A sharp skew and a shortage of headroom precluded the possibility of an arch, and a flat-topped reinforced-girder design was adopted. The bridge is 55 ft. wide and has a skew of about 58 deg. Seven girders on about 9-ft. centers span the 29-ft. right-angle distance between abut-



Details of Reinforced-Concrete Canopy



Cross-Section of Watsessing Avenue Station on Center Line between Tracks; Arch Proper at Extreme Left

ments. The triangle on either side is carried by three girders parallel to the street, the outer one being 56 ft. long and 4 ft. 10 in. deep, using ten 1¼-in. reinforcing bars and being capped with a distinctive concrete baluster. Both ends of these longest girders are carried by the abutments, but one end of each of the two shorter girders in the triangle is carried by the outside girder normal to the abutments. A special girder had to be used, with more steel, including bars at the top, to help out the concrete in taking the compression.

WATSESSING AVENUE STATION

On account of the confining retaining walls and the lack of space to develop suitable approaches it was decided to build the new Watsessing Avenue station directly over the tracks on Watsessing Avenue, which was to be carried by a flat elliptical arch. The avenue is on a small skew, but the normal span is 53 ft., which is reduced under the station to about 48 ft. by an inclosed stairway from street level to platform on the south side. On the north side is a basement, formed by a recess in the wall, for the 36 x 20-ft. annex. Some of the details are shown.

The station is supported on four reinforced-concrete girders, the bottoms of which are shaped to the form of the arch carrying the avenue, the effect of a continuous arch under avenue and station being produced by means of a thin concrete ceiling in the intervening spaces between girders and between arch and girders. It will be noted that the four girders differ radically in design. The two in the center are designed as simple beams spanning the entire 48 ft., resting on the partition walls separating the basement and the stairway respectively from the track platforms. With the other two girders it was possible to utilize for anchorage walls lining up with them beyond the partition walls and design the ends of the spans as cantilevers, greatly reducing the theoretical beam span and the necessary amount of steel. Attention is called to the smoke shield in the longitudinal section. It is apparent that the smoke and gases, which have such a disfiguring effect on overhead bridges, would be especially objectionable at this point unless arrested in some manner. The curved overhang adopted has served its purpose well. The view of the station shows that while the shield itself has already been blackened, the station walls are untouched.

As the view of the station shows, the reinforced-concrete canopies at this point are of an entirely different design from those used at Bloomfield. The brackets are cantilevered from the retaining walls in the manner shown, the thickness of the walls at the base being increased to nearly half the height to take care of the extra overturning moment.

East of the station are an elliptical highway arch carrying Arlington Avenue and a steel through-girder bridge carrying a branch line of the Erie Railroad. The arch is similar to that adopted at Watsessing Avenue—designed as a succession of arch sections 2 ft. wide parallel to the center line of the crossing, the skewback being stepped horizontally to conform with the skew of the arch.

PERSONNEL

Reiter, Curtis & Hill, of Philadelphia, did the grading at Glen Ridge and practically all of the construction work at Bloomfield and Watsessing, with the exception of the stations, which were built by Mr. A. E. Badgley, of Binghamton, N. Y. All track and temporary work, and everything at Glen Ridge except the grading, were done by company forces. Mr. G. J. Ray, chief engineer, was in general charge of the improvement, and Mr. G. T. Hand, division engineer, had its more direct supervision, assisted by Mr. F. J. Nies, architect (who handled the design of the stations, canopies and grounds); Mr. A. B. Cohen, concrete engineer; Mr. A. E. Deal, bridge engineer, and Mr. W. H. Speirs, resident engineer on the work.

Work of Office of Public Roads

Experimental Roads Built, Materials Tested, County Boards Advised and Post Roads Investigated during 1912-1913

BUILDING 500,028 sq. yd. of experimental and object-lesson roadway takes rank over investigations of road materials and educational extension work as the most important feature of the report of Mr. Logan Waller Page, director of the Office of Public Roads, Washington, D. C., for the fiscal year ended June 30, 1913. Object-lesson roads to the extent of 440,898 sq. yd. cost, exclusive of salaries and expenses of engineers furnished by the office, $92,151; 59,130 sq. yd. of experimental road completes an area equivalent to about 61 miles of 14-ft. road.

SQUARE YARDS OF OBJECT-LESSON AND EXPERIMENTAL ROADS CONSTRUCTED DURING 1905-1913 INCLUSIVE

Material	1905	1906	1907	1908	1909	1910	1911	1912	1913*
Brick	.....	.....	.....	.....	.....	526	.....	.....	2,055
Concrete	.....	.....	.....	.....	.....	1,004	.....	.....	3,013
Oil-cement concrete	.....	.....	.....	.....	.....	.....	1,917	.....	1,744
Bituminous-concrete	.....	.....	.....	.....	.....	.....	.....	.....	2,898
Bituminous-surfaced concrete	.....	.....	.....	.....	.....	.....	.....	.....	4,178
Bituminous-macadam	.....	.....	.....	.....	.....	45,832	41,551	34,453	16,040
Surface treatment	.....	.....	.....	.....	.....	.....	.....	.....	6,386
Macadam	44,944	51,246	76,376	72,587	96,107	50,333	11,330	14,806	57,131
Asphalt-slag	.....	.....	.....	.....	.....	.....	578	.....	.....
Oil asphalt-gravel	.....	.....	.....	.....	.....	.....	900	.....	.....
Oil-gravel	.....	.....	.....	.....	.....	4,819	9,774	.....	.....
Gravel-macadam	.....	.....	.....	.....	.....	.....	.....	.....	2,607
Gravel	8,804	4,197	11,722	4,608	65,793	71,376	59,942	13,057	63,730
Slag	.....	.....	.....	.....	.....	4,610	.....	.....	.....
Sand-clay	19,178	19,443	85,571	42,634	205,032	177,960	218,177	103,876	128,496
Sand-gumbo	.....	.....	.....	.....	.....	.....	.....	.....	5,337
Burnt-clay	400	.....	.....	3,392	2,041	.....	.....	.....	.....
Shell	5,877	933	.....	14,020	1,630	.....	.....	.....	43,717
Earth	.....	12,132	27,042	85,967	319,456	651,109	140,933	556,663	162,696
Total	79,203	87,951	200,711	223,208	690,059	1,007,569	485,102	722,855	500,028

*Includes experimental roads.

There were 41 object-lesson stretches, classified as follows: Two bituminous macadam, 7 water-found macadam, 4 gravel, 1 gravel-macadam, 14 sand-lay, 1 sand-gumbo, 3 shell, and 9 earth. The three experimental roads were built of bituminous concrete, bituminous-

Hillside Avenue Bridge—Steel Incased in Concrete

Glenwood Avenue Bridge—Main Girders Only of Steel surfaced concrete, oil-cement concrete, cement concrete, brick, bituminous-macadam, shell or water-bound macadam and in some instances surface treatments were the subjects of the tests. The table gives the area of each type of object-lesson roadway constructed during the fiscal years 1905-1913, as well as experimental roads for 1913.

Typical designs for steel and concrete bridges—steel structures with spans of 30 to 150 ft.; concrete, 2 to 16 ft.—were prepared, and 350 blueprint copies have already been furnished, upon proper application, to road officials for use at specific points. About thirty special designs were also distributed. One separate bridge-construction project intended as an object lesson was supervised during the year.

From Aug. 24 to Nov. 23, 1912, an engineer and assistant were stationed at Natchez, Adams County, Mississippi, to devise a county system of roads, making surveys for relocation, investigating materials, designing road structures and advising the county officials as to construction, administration and maintenance for a 120-mile system. The work was completed, with estimates and specifications, ready for advertisement when the engineer was withdrawn. The estimate called for an expenditure of $126,000; the section was 24 ft., 14 ft. of which is to be gravel-surfaced; the maximum grade is to be 5 per cent.

Similar work was undertaken for Nueces County, Texas, where sand-clay and gravel roads are built, and Smith County, Texas, where it is expected that $232,581 will be needed to complete a system of 120 miles of graded earth and sand-clay roads. Special road problems caused fifty-nine assignments of engineers and chemists in twenty-three States.

Studies and Investigations

In connection with the $500,000 carried by the post-office appropriation act of Aug. 24, 1912, the office made twenty-six inspections of designated post roads in eighteen States, covering 1,143.11 miles. Economic studies covering the determination of traffic areas and the saving resulting from the reduction in cost of hauling were instituted with the traction dynamometer, which, as described in the Engineering Record of Dec. 6, 1913, page 631, automatically registers the pull in pounds required for a standard load on standard widths throughout the length of a road.

Investigation by the office so far indicates that about $250,000,000 in highway bonds has already been voted by counties and towns and that the present rate of increase is between $20,000,000 and $30,000,000 annually.

Eight hundred and thirty-nine samples of road materials were tested in the physical, chemical and petrographic laboratories—638 pieces of rock, gravel, sand, clay, marl, cement, concrete, cinders, brick, soil and slag, and 201 samples of oils, asphalts and tars—representing an increase of 25 per cent in one year. In addition, quantitative analyses of 33 samples were made in the petrographic laboratory, while 373 were examined chemically and mineralogically. One hundred and twenty-four bituminous specifications were issued.

Twenty-nine representatives of the office delivered 558 practical or scientific addresses to a total of 95,948 auditors. In all but one State a collaborator is maintained to report on the first of each month all road matters of importance.

The report is concluded with the statements that seven publications were issued during the year and that 1,796 photographic negatives were added to the present collection.

Pumping Water Against Pressure of 2250 Pounds

Method of Supplying Locomotives on Rack Railway Up Mount Washington

By C. BLAND EDWARDS
New York City

OPERATING against a pressure of 2250 lb. per square inch, duplex pumps at the base of Mount Washington, New Hampshire, force water to the summit through a 2-in. pipe line 3.3 miles long, with a maximum vertical lift of 3725 ft. The water is used in the boilers of the Mount Washington Railroad locomotives, which are of the rack-and-cog type and climb grades of 36 per cent. It was necessary, therefore, to lighten the loads as much as possible, and for this reason water is supplied from tanks alongside the track instead of being stored in large quantities in the locomotive tenders. The springs along the mountainside are not able, however, to meet the demand during August, and as transportation to the summit is maintained through September it has been necessary to provide a new source of supply during the period of the springs' inactivity. A further need of the plant was to furnish a satisfactory water supply for the new hotel planned for the summit.

Pipe Line along Rack Railway to Summit of Mount Washington

A pair of Dean duplex steam pumps were installed at the base station at an elevation of 2540 ft. above sea level. They are special heavy-pressure outfits with forged-steel, non-breakable pump ends. The pumps are operated under a steam pressure of 100 lb. furnished by a 10 x 5-ft. boiler of the upright fire-tube type, with provision for a second boiler when increased capacity is required. The pump cylinder on the steam side is 16 in. in diameter, while that on the water side is 3 in. in diameter; the stroke is 18 in.

The pumps, operated either singly or together, have a maximum output of 30 gal. per minute, the size of the delivery pipe and the pipe friction limiting it to this amount against a pressure of 2250 lb. The pressure at the intake is 80 lb. and is furnished by a dam in the Ammonoosuc River. The pumps are housed in a 20 x 20-ft. building of corrugated steel fastened to a wooden frame with boiler and accessories—water pump, inspirator, and feed-water heater. The pumps have a specially designed governor that maintains simple but effective control at all times.

Water is pumped from an elevation of 2540 ft. at the base to an elevation of 6280 at the summit through a specially designed pipe 2 in. in diameter, having a wall ½ in. thick for half the distance and ⅜ in. thick for the remainder. The pipe is fastened to the stringers and laid on the trestle bents that support the railway track.

Along the pipe line expansion joints were used every 360 ft. The expansion joints, which were flanged, were of extra-heavy brass, of the Crane Company's manufacture. Midway between joints a steel flange union was inserted. The remainder of the pipe line was made up with screwed couplings of the ordinary type. Owing to the liberal air chamber at the base of the mountain no trouble has been experienced from water hammer. At the base the pipe from the pump crosses the track and the pipe leading up the mountain is connected to a tee. Beyond this tee is an ell, and from that ell a 100-ft. length of pipe, with a dead end to serve as an air chamber, was laid in the same trench following the slope of the hill.

The pumping plant, which supplies seven tanks along the railway line, was designed by Mr. A. B. Corthell, chief engineer of the Boston & Maine Railroad, and installed under the personal direction of Mr. F. D. Hall, electrical engineer. Mr. H. G. Spaulding supervises the operation of the plant. The season from May to October, 1913, is the first full season the plant has been operated, and although the vibration of the rack road to which the pipe line is fastened is considerable, this has not affected the pipe joints in the least. To keep the tanks full it is necessary to operate the pumps about ten hours each day.

New Bridge over Thames

The present handsome structure of the Southwark Bridge over the Thames in London, which was completed in 1819, is to be replaced, owing to its insufficiency to present needs, both as regards capacity and its steep approach grades, which amount to 5 per cent. The old bridge consists of three cast-iron rib spans, the center one being 240 ft. and the others 210 ft. In the new bridge the existing abutments will be used, and the spans will be of the same number, the center one being 140 ft. 6 in., the next two 131 ft. 9 in., and the abutment spans 123 ft. The minimum headway will be 26 ft., which is less than that of the present bridge, and will enable the gradients to be reduced to 3.3 per cent, while the width of the roadway will be increased to 35 ft., and of the sidewalks to 10 ft. Part of the latter will be supported on cantilevers. Of the four new piers, the two at the center will be 15 ft. wide and 42 ft. high, and the others 14 ft. wide and 41 ft. high. They will be founded on steel caissons sunk under compressed air, the filling being of concrete. Each span of the bridge will consist of seven steel ribs, the depths of which range from 3 ft. 3 in. to 3 ft. 6 in.

The new work has been designed by Mott & Hay, Mr. H. J. Deane having carried out the preparation of the plans.

Troy Union Station Depressed Concourse

First New York Central Enlargement and Adaptation of the Pedestrian Subway to Serve as an Auxiliary Waiting Room

By J. R. TAFT

Assoc. M. Am. Soc. C. E.; of Emory & Eisenbrey, Engineers, Philadelphia and New York

It is the usual custom for an engineer to write an article describing a particular piece of work soon after its completion, which, of course, has the advantage of furnishing material fresh in the author's mind. On the other hand, when this is done sufficient time has not elapsed to test thoroughly the suitability of design or the integrity of construction. It is with the latter idea in mind that the writer presents this description of a piece of work completed and put into service about ten years ago. The Troy subway concourse has long held a unique position in railroad construction. This is not only on account of its structural details but also on account of the unusual purposes for which it is used, namely, not only as a subsurface passage to and from trains but as an underground waiting room. The results obtained have amply justified the extra expense of this construction as compared with previous works of an approximately similar nature.

This work was designed and executed by the New York Central & Hudson River Railroad Company as part of an improvement which involved the construction of a new union passenger station at Troy, N. Y. These properties are used jointly by the New York Central, the Delaware & Hudson and the Boston & Maine. The function of the facilities is not so much that of a terminal as of an important through station, being in fact on a busy loop linking Troy with Albany.

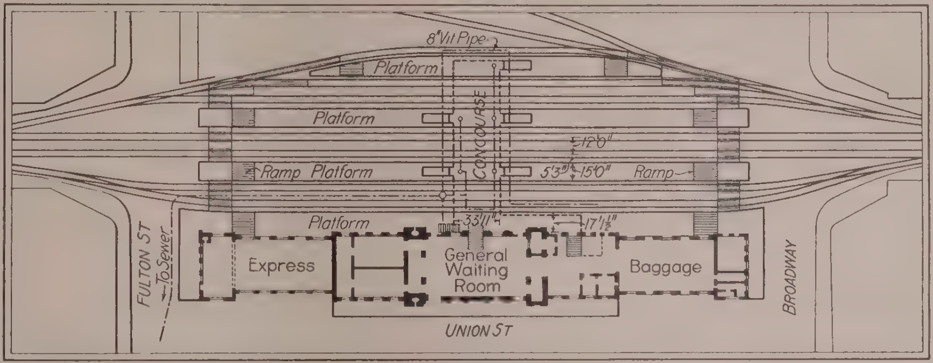
General Arrangement

From the passenger station facing Union Street two stairways lead down into the concourse. One leads from the general waiting-room direct, and the other, near the baggage room, leads down into a passage or "parallel subway," and thence into the concourse. This relieves congestion in the waiting room by obviating the necessity of passengers returning through the waiting room after checking baggage. Congestion in the concourse is relieved through doors to the nearest platform, which is also reached from the concourse by a stairway. Except by crossing the tracks, the island platforms may be reached only by stairways leading up from the concourse.

Generally speaking, this work involved the usual features met with in railroad structures. Traffic had to be maintained continuously, which necessitated building the work in sections, putting one track, and sometimes two, out of service. Work was carried on through a severe winter, which entailed the extra cost of heating materials when the temperature was in the vicinity of zero. Owing to freight-car shortage at this time, frozen materials had to be removed from gondola cars, and this involved additional cost, not only from handling but from rehandling caused by the limited storage space on the work.

The tracks were supported on pile bents during the excavating. The material encountered was a moist clay. Considerable trouble was experienced from a spring near the junction of the "parallel subway" and the concourse, which later proved of great annoyance during waterproofing. Pumping and bailing were necessary throughout the work.

The type of structure is shown in the transverse section. A base of concrete was placed and shaped to the proper contour to receive the waterproofing. Above this, concrete reinforced with wire mesh was laid in the form of inverted arches acting in the center of the concourse against a row of 20-in. 65-lb. I-beams and along the sides of the concourse against the abutments or walls. These I-beams were fastened to the columns supporting the superstructure. This type of construction served both to anchor the column bases and to withstand any upward thrust from pressure due to extreme high water in the Hudson River, which is several feet above the finished floor level. Anchor bolts through the column bases were omitted to avoid piercing the waterproofing underneath.



General Plan of Station, Platforms and Track Arrangement

Below the waterproofing in the foundations the concrete was mixed in the proportions of 1:4:7½; in the beam seats, 1:1:2; in other parts of the structure, 1.3:6. All concrete was mixed and placed by hand.

An 8-in. open-joint tile drain was placed around the outside of the entire concourse and led into a manhole connected with the street sewer. Where this drain passed under stairwells cast-iron pipe was used. A 4-in. cast-iron pipe was laid in the space between the concourse floor and the inverted arches underneath leading into the same manhole. Bell-trap cesspools were placed at such points as were necessary to take care of any water which might enter the concourse by the stairwells. Great caution was exercised where this pipe passed through the waterproofing near the manhole. A gate valve and a backwater valve were installed as an emergency precaution against water backing up from the Hudson River through the sewer and into the concourse.

Under the floors, stairs and side walls to an elevation of 5 feet. above the finished floor level the waterproofing consisted of six thicknesses of wool felt swabbed with seven coatings of asphalt. Above this height and to the top of the back walls three-ply was used. At some points under the floor it was not possible to get more than six coatings of asphalt on account of the dampness of the concrete bed. Good results were obtained at such points by dusting a little dry cement over the moist concrete.

The longitudinal laps of felt were made 3 in. wide and the end joinings overlapped 12 in. The first sheet of any layer was started in the middle of the sheet beneath. Owing to bracing, falsework, etc., the waterproofing had to be laid in small areas, a condition which left unprotected much uncoated surface for future joinings. Great care was exercised to prevent the punching of holes through the waterproofing while bracing the forms for the side walls. All holes thus made were carefully patched before placing concrete. The waterproofing of the concourse was joined to and made continuous with the waterproofing around the foundation of the station building. A protective covering of vitrified paving brick was laid on edge in Portland-cement mortar up the outside of the side walls, as shown.

Superstructure

The steel superstructure was of deck-plate construction. The columns on the center line of the concourse support the longitudinal girder, which carries one end of the I-beams and deck plate. The cantilever ends of this girder support one end of the fascia girders, which carry the platforms and the heaviest part of the ornamental terra cotta.

Each deck system was shipped in built-up half-sections, and when erected all joints were provided with cover plates having the edges carefully sheared for the purpose of calking to a bevel at an angle of 30 deg. with the vertical. Except at the corners and at the stiffener angles over the columns, the joints between the deck plates and girders were provided with angle plates whose vertical and horizontal edges were cut to a bevel. The steelwork was so designed that the clearance around the edges of the deck plate would be not more than 1/16 in. This tight fitting made erection rather difficult, and in some instances it was necessary to cut out a number of shop rivets and use "steamboat" ratchets to draw the deck system together. The pitch of rivets along a calked edge was not more than 2¼ in.

After the erection was completed and the field riveting finished, all the edges of plates and angles visible on top of the deck plates were calked with a calking iron. Spaces around the corners and at all other places in the joints of the deck plates were thoroughly calked with iron filings and salammoniac well rammed and packed so as to form a fillet above the joint. When the calking was finished and before any field painting was done the superstructure was thoroughly flooded with water from a locomotive tank. This test proved satisfactory in every respect, no leaks being apparent. Two field coats of paint completed the steelwork of the superstructure, during the erection of which only two tracks at a time were out of service.

A 1-in. coat of 1:1 Portland-cement mortar was spread over the deck plate and carried up the sides of the fascia girders. This covered the rivet heads and formed a smooth bed upon which to lay the waterproofing. The waterproofing here was similar to that placed under the concourse floor, and consisted of six layers of felt and seven coatings of asphalt well flushed up the sides of the fascia girders and under the angle-bar overhang of the platforms. The platforms themselves were not waterproofed. The buckle plates were calked around their edges with salammoniac and iron filings, and on these plates the finished platform was laid.

A course of vitrified paving brick laid flat over the superstructure under the tracks protected the waterproofing from being cut by ballast under the impact of trains. The paving brick was of the best quality, such as is used in street paving. When the bricks were in place their joints were run full of hot asphalt and hot sand was poured simultaneously from separate vessels. After filling all the joints the entire surface of the brick was spread with a coating of hot asphalt and hot sand.

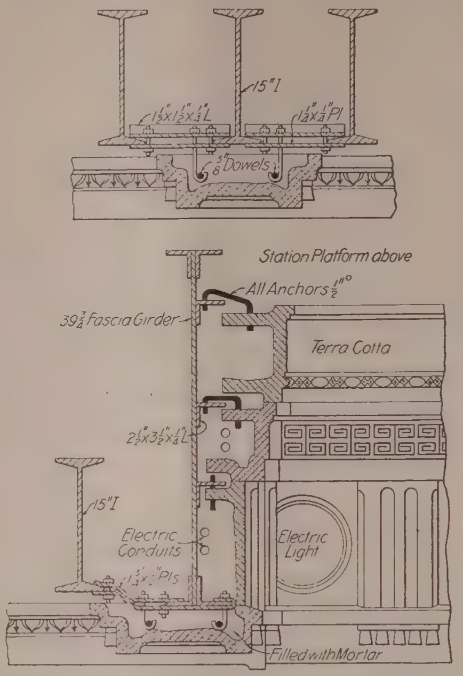
DISTRIBUTION OF COST OF WORK

	Per cent.
Superstructure steel	8.0
Opalite tiling	1.6
Terra cotta	5.8
Electrical work	1.6
Heating	1.0
Vault lights in platforms	1.4
Shelter sheds	12.5
Total contract work	31.9
Work by company forces	68.1

The floor of the concourse is, as shown, a 3½-in. slab of 1:3:6 concrete topped with ½ in. of mortar. The side walls, including stairwells, are faced with white opalite tiling laid on a mortar scratch coat up the face of a common brick wall, separated from the concrete walls of the substructure by a 1-in. air space, which was provided for vent and anchors.

TRIMMING AND CASINGS

White ornamental glazed terra cotta was used for the trimming of ceilings and walls and casings of columns, each piece being numbered in accordance with working drawings furnished by the contractor for this work. The methods of anchoring were carefully worked out and all anchors were tightly fitted so that the terra cotta would be held in position without the aid of mortar, which was slushed into all its hollow spaces, except at such spaces as would interfere with electric lights. The hollows between the terra cotta and beams above were also filled with mortar. The end webs were set back so that the anchor space was at least 1¼ in. wide. The pieces were fitted to a ⅛-in. joint which was raked out to a depth of ½ in. and pointed after the work had set. Different types of structural shapes carrying the hangers required different types of hangers, but the general method of support was the same. The terra cotta was furnished for a fixed sum f. o. b. cars on the work. Highly skilled and experienced setters were employed by the contractor furnishing the material at actual cost plus a percentage.

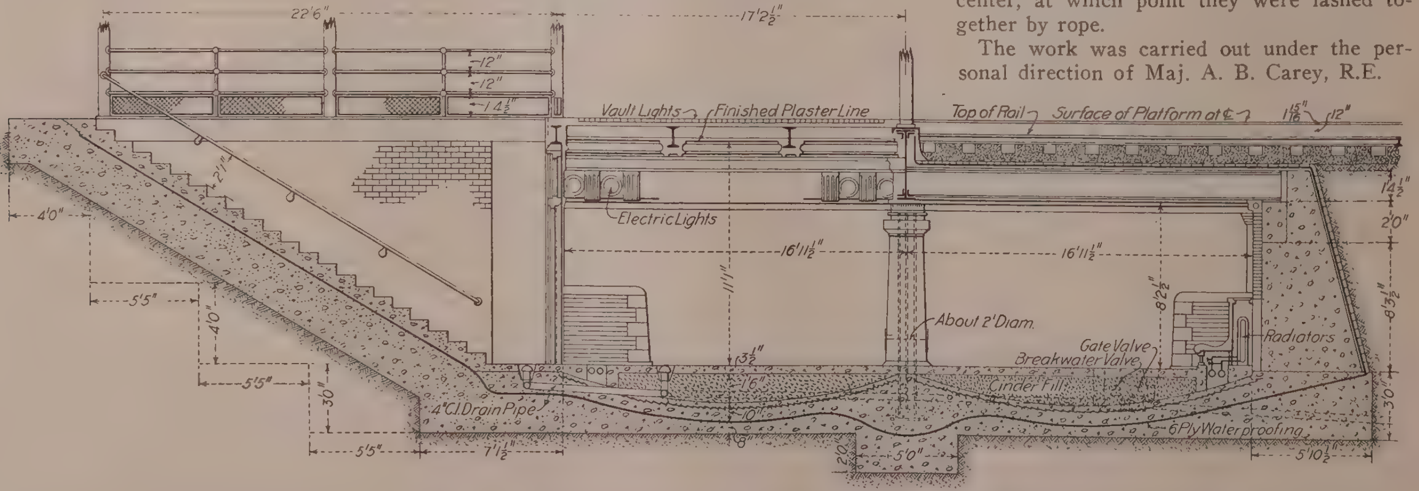


Methods of Supporting Ornamental Work

Ceiling slabs about 1½ in. thick, composed of 1 part Portland cement, 3 parts sand, and 1 part lime paste, were suspended by No. 10 galvanized wire netting of 1-in. mesh drawn taut across and tied with No. 16 copper wire to 2 x 1½-in. T's fastened under the 15-in. I-beams of the superstructure floor system. The slabs were of such consistency that when the mortar was troweled through the net it would be held from falling back. The face was brought to a true surface about ¼ in. below the net and floated to a sand finish. The concourse is electrically lighted throughout and heated by a hot-water system radiating from back of seats.

COSTS

The substructural work, the erection of the superstructure, and the building of the platforms were handled by company forces on a cost basis. The contract work covered the superstructure material, the interior finish (including light and heat) and the canopies. The cost of the concourse, together with the station platforms and shelter sheds, was about $28.40 per square foot of available concourse floor space. The cost may be distributed as shown in the table.



Transverse Section of Concourse, Showing Structural Features, Waterproofing, Drainage and Other Details

For the beauty and utility of design of the treatment of the interior we are indebted to the former architectural firm of Reed & Stem, of New York City, who were also the architects of the passenger station built at the same time. This firm has since been succeeded by Stem & Fellheimer. The work was executed through the office of the chief engineer of the New York Central & Hudson River Railroad by the resident engineer at Albany. The writer was assistant engineer in direct charge of the work.

Army Engineers Build Bridge by Hand Labor

THE Third Fortress Company of the Royal Canadian Engineers recently spent six weeks in field practice in the neighborhood of North Vancouver, B. C., in the course of which a structure designated as the Claxton-Fiddle inverted, rigid-suspension bridge was constructed in twenty-eight hours by a force totaling fourteen men. The structure had a span of 92 ft. and was designed to carry a total, uniformly distributed load of 14 tons. Two pairs of 20-ton cable were used to support a floor system of timber which was braced and guyed so as to give it a high degree of rigidity; 3,000 ft. b.m. of cut lumber were used, in addition to the vertical supports and their braces.

The most arduous part of the work was the digging of the trenches to hold the anchorages of the wire cables which carry the load. These were sunk 18 ft. deep at right angles to the two main cable lines, and in them were buried logs 14 to 16 ft. long and 15 in. in diameter. From these trenches inclines were excavated to carry the cables on a straight line from the anchorages to the cross-bar supported on uprights extending 14 ft. above the bridge floor at either end of the structure. The lower ends of the uprights supporting these cross-bars were sunk in holes dug for the purpose, and were braced in two directions by timber struts attached to the uprights well above the bridge floor. Care was taken to brace these uprights firmly in a vertical position so that the strain from the cables would be transferred direct to the ground.

A movable transom was slung from the main cables and was used to place the vertical tie cables, from which, in turn, the floor system was extended out from either bank. Operations proceeded simultaneously from both banks until the span beams met at the center, at which point they were lashed together by rope.

The work was carried out under the personal direction of Maj. A. B. Carey, R.E.

Problems of the Contractor

Part I—Abstract of Address by Leonard C. Wason on Organizing and Executing the Construction of a Reinforced-Concrete Industrial Building

FIRST-HAND observation of the development of a structural firm along lines of efficiency furnished Mr. Leonard C. Wason, president of the Aberthaw Construction Company, with the convictions which he has embodied in a paper published by the Association of Engineering Societies. This first installment of an abstract of his remarks treats of the dominance of the human element in dictating the success of a construction organization, besides giving sidelights on the properties a builder should look for in a contract, and sketching the preliminary considerations demanding study in the construction of a reinforced-concrete mill building.

Mr. Wason believes most positively that no matter how great the ability in every direction of any one person, and in spite of unlimited help and financial resources, the owner's interests in the long run can better be served by two persons—the engineer and the contractor—working together than by one alone performing all these duties.

HUMAN ELEMENT

As sometimes the owner takes an active interest in the execution of the work, although he deals through his engineer or architect, it is of considerable importance to know his temperament and point of view. Greater harmony will thus be obtained. The engineer will do well to bring both parties together early and often. There is the owner who has not been seen at the time of final payment, and the one who is in evidence every day—the one who has a technical training and knows, and the one who does not know about construction, but thinks he does, and personally mixes into the work commonly considered as the engineer's. If the engineer is weak-kneed with the last-named type of owner expense and misunderstanding are almost certain to result, primarily because no man can serve two masters, and, secondarily, because an ignorant master, the owner, is never satisfied. If there is a very strong, fair-minded engineer who commands the respect of his client there is little trouble with any type of owner.

Then it is necessary to study the engineer or architect and consider his method of handling and supervising work. The methods of some engineers are radically different from those of others; this has a marked bearing upon the cost of the work and sometimes on its desirability to the contractor. The contractor must determine what sort of treatment he will receive. Nothing adds to the price of a bid like uncertainty, whether it be in the temperament of engineer and owner or in unknown construction problems.

In one case where a number of local firms were invited to bid on a certain large building for an architect who was well known always to rule in favor of his client, irrespective of the merits of the case, the successful bidder, after figuring full measure on all quantities, added this item—"Humor architect"; the item was 10 per cent of the contract. It is safe to presume that all other competitors placed this contingency at a higher figure. Such a man could not get a reasonable bid from any one who knew him, and he certainly could not expect to let work advantageously to guileless strangers.

One of the great problems which the contractor has to face is that of the inspector who represents the engineer on the work. A thoroughly competent inspector is a great help to the contractor and very beneficial in the results obtained. An incompetent one is exactly the reverse. The writer recognizes the difficulties the engineer labors under in selecting his inspector. The duties are not hard, and to the man with ability, ambition and push, the close confinement to long hours of attendance on the work, with little to do except keep his eyes open, is too irksome to be long endured, even at a good salary, and this desirable type soon moves to what he considers better employment. The most important thing to consider in the appointment of an inexperienced man is his temperament. He must have an even temper not easily ruffled, be considerate yet firm, always diplomatic, and be capable of performing his duties acceptably to his employer.

The superintendent for the contractor is necessarily better informed and trained in construction, an executive who is constantly directing others and quick to resist for the good of the service insubordination or usurpation of the duties for which he is held to strict account by his employer. In other words, he is trained to be an autocrat. This temperament does not take kindly to being bossed by a younger man admittedly with less experience. Therefore, the inspector must have the above-named qualities and also must not consider it a personal affront when his orders are overruled. He will make some mistakes which the engineer will correct, and many more, alas, which his chief will never hear about, although they make unnecessary expense and may affect his chief's professional reputation. He is put in a trying position, left too much alone and required to perform certain duties, but he must not go beyond bounds.

The very first step which a contractor must take in starting the execution of a job is selecting a general superintendent to handle the work. The type that is hired for a single job and discharged at its completion is not worth having. The really desirable superintendent is a development from experience, the one survival from many tried, and when once obtained a firm cannot afford to lose him. Some owners and engineers appreciate the value of personality so much that they have given the writer's company contracts under condition that a certain superintendent be put in charge.

If a building superintendent is to be successful he must combine at least seven qualities. He must have brains, special and technical knowledge of both direct contract and subcontract work, tact, energy, honesty, judgment and good health. He must have a personality which drives to activity several hundred originally unorganized men who are without special interest in the company they work for or in the result accomplished, and with such tact and judgment as to weld them into a harmonious working force, cheerful and self-respecting, with high morale and ultimately with enthusiasm for the work in hand. He carries a care so great that he builds in full size, with permanent materials, the intricacies of design which trouble the engineer's drafting room to show clearly on paper; with an honor so fine that the company is ready to leave its reputation in his hands, to trust him with funds; and with special experience so trained that dangerous operations are carried on as a matter of routine, without worry to himself or the company, yet with a constant oversight of a thousand chances for accident or perhaps death which may occur to the men in his charge; with a forethought so great that he sees ahead and provides for the problems which are to come up perhaps months later; with a temper so good that he never loses self-control under the most provoking circumstances, and is able to take with the best of grace changes in his plans from the office, and to work in the close co-operation with the company which is so necessary to make it an effective contracting organization.

Such men have a temperament that responds quickly to criticism or praise. Praise comes sparingly, even when deserved, while criticism is freely meted out. The attitude of the engineer in this respect is reflected in the execution of the work. One engineer may call attention to a mistake with a letter that is harsh and ends with a sting, which leaves the feeling of injustice and soreness in the recipient. Another, in calling attention to a similar matter, ends his letter with some expression like the following: "We appreciate your wish to make this work as satisfactory as possible, and recognize that this occurred through failure to understand my exact requirements." In response to such a letter as the first, the tendency is to do just as little as will satisfy the engineer and take your own time about it. But, as the writer knows from personal experience, in response to the second letter, you jump to correct the trouble cheerfully, quickly and without comment, and also sometimes do more than was asked for.

THE CONTRACT

The type of contract is manifestly of considerable importance. It is the firm opinion of the writer that the usual type of lump-sum contract obtained in competitive bidding does not give an owner the best results. With competitive bidding open to all, the lowest bidder is liable to be one who does not use the best of methods, is looking for all sorts of short cuts, and is frequently one with a limited amount of experience and capital. It has been often noted that those new in the reinforced concrete field underestimate the difficulty and cost and do work badly at first, no matter how experienced in other lines. The lowest bidder is squeezed to a figure where it is known he cannot make much, if anything, and there is every incentive to save and slight. This condition of necessity encourages mutual suspicion and antagonism before the start; therefore, the best results are impossible. No amount of careful inspection can make an inexperienced or incompetent contractor turn out thoroughly first-class work.

On the other hand, under the cost-plus-fixed-sum-for-profit type of contract the interests of the owner, builder and engineer are one. Work obtained in this way is certain to be much better for the same cost; even if the cost is slightly greater, the owner has the assurance that he is getting much more for his money. The majority of manufacturers whom the writer knows look upon a mill building as a tool to be used in a manufacturing process, rather than as real estate, and want to get a thoroughly first-class tool rather than the absolute last dollar knocked off the first cost of real estate, and, therefore, believe the extra cost justified. The engineer can examine the estimate of cost as prepared by the contractor, discuss savings or changes, and can see places where he is willing to cut the design when he knows that there is not going to be still further cut in the execution of the work. When he knows that the work is going to be executed exactly as designed he can design with greater precision and economy than when he has to provide extra strength or size of members to allow for a possible lack of quality of materials and workmanship by some unknown person who may have the execution of the work in hand. The work can be carried on also much faster under this method of close co-operation than under the other, where there are likely to be misunderstandings which must be adjusted before the work progresses further. What the contractor has to sell is service, and what the owner wants is results, and where this mutuality exists both parties can accomplish the end which they are striving for.

If the owner wants to start as soon as he engages an engineer and before plans are started, he can save about six weeks' time with no serious difference of cost on the cost-plus-fixed-sum basis.

The engineer and owner do not sufficiently appreciate that the builder or contractor is largely a broker buying materials. With an office building, for instance, the general contractor may not handle more than 10 per cent of the contract price as direct labor. The rest is materials bought and subcontracts let. With reinforced concrete the percentage of labor is larger than in any other building operation. It averages about 35 per cent of the cost. The contractor, therefore, realizes the necessity of a first-class purchasing department.

Preliminary Work

When a contract is awarded and a set of plans received from the engineer a considerable amount of work is done in the main office, beginning long before any work is started in the field and continued during the early stages of construction in two departments—the designing and the purchasing.

The function of the designing department is to take the complete set of plans and make a careful study of these in regard to designing forms, tabulating steel and illustrating and tabulating other materials, such as doors, windows, architectural iron, etc., where this is not done in the engineer's office. The location of construction and contraction joints is studied, and on rare occasions the structural design is reviewed. In the writer's practice it is common to close a contract and start building before any working drawings are made. Then the work and responsibility thrown on the designing department are very great.

Chief among the minor features not shown on the plans are the means to be provided to prevent cracks, which mar the appearance and are often a source of annoyance, though seldom a cause of structural weakness. There are sometimes cracks caused by unequal settlement of foundation. Sometimes a part of a building is on piles and part on earth. Where they join it is hard to foresee and provide such an amount of bearing that the whole will settle evenly. It is usually best to provide a broader bearing on the less rigid material than theory dictates; then unsightly cracks may be avoided by very rigid tying of the building together with reinforcement, against pulling apart longitudinally or shearing. This requires both horizontal and diagonal reinforcement with a minimum quantity, equal to at least one-half of 1 per cent of area of concrete.

Another way to overcome the same difficulty is by building a joint vertically clear through the structure at this point and designing the members of the structure on either side so that if settlement does occur they will not crack. This was done with satisfactory results in a recent building where one end rested upon sand, the center on ledge and the other end on clay.

On the ground of cheapness of construction, it is almost always better to put curtain walls in after the frame is up; the work then goes ahead much faster. Weather-tight joints can readily be made, and the joints between the frame, that is, the columns and floor, can be concealed so that no unsightly crack is visible.

Another point of design which may sometimes be advantageously discussed by the engineer is that of roof construction; whether the structural part shall be flat and covered with cinders, to give a proper pitch for drainage, or whether the ceiling shall be pitched and the fill avoided. In construction the most serious objection to the first method is that so much time elapses between the casting of the roof and the waterproof cover of tar and felt over the cinder fill that a considerable quantity of rain collects on top of the roof slab. These slabs, while not absolutely watertight, are tight enough to hold a considerable quantity of water. On some jobs holes had to be drilled from ceiling to drain roof slabs. In one building water dripped from the ceiling after it had been waterproof for a period of five months, due to the collection of water on the slab in the cinder fill. In another case there was some dripping even after two years. This is a matter entirely beyond the control of the contractor.

It is somewhat common to put wall beams above the floor on account of letting in light at the ceiling line. Then the question arises whether the beams shall be cast with the floor or be cast separately. It is generally cheaper and of equally good construction to cast the wall beam as a separate operation, allowing the ends to rest in rebates in the columns and suspending the slab below by means of stirrups. Provision can be made for continuity by casting some holes in the columns above the floor at the proper points, through which the reinforcement for negative bending moments will pass, allowing the ends to extend well out in the adjacent panels. When properly grouted into place and panel cast this will be as strong as if cast as a monolith with the floor.

In one building of large size, in a single floor there were in the original design received 455 different sizes and styles of beams. The designing department of the writer's company found it possible, without impairing the result to be accomplished, to reduce these to less than a tenth of the original number, and by co-operation with the engineers finally succeeded in reducing the number to 52. If the engineers realize that in the building of wooden forms for maximum economy these are made from plans drawn to scale at a bench on the ground and assembled in place without the use of any tool but a hammer, it will be seen that almost as great precision must be used in construction as with structural steel.

The question of change of size of columns in every story, or once in two or three stories, is one of cost. The expense of changing the forms is usually greater than the cost of concrete saved on small columns where the reduction is less than 3 in., and on large columns where the reduction is less than 2 in. Therefore, it is not often economical to change the size every story. Often when the column is reduced it is desirable to use ahead the size of lowest story columns in order to avoid the expense of splicing out beam and girder sides and bottoms. Sometimes when the upper floor has a lighter load than the lower it would be possible to reduce the size of beams. Economy dictates that the depth may be reduced but not their width, because this would require splicing out all the floor panels and joists, which is more expensive than the saving in concrete.

(To be concluded)

An Engineer for Interstate Commerce Commission

American Institute of Consulting Engineers Urges President Wilson to Appoint Technically Trained Man

Continuing its efforts to secure the appointment of engineers to administrative positions for which their technical training makes them peculiarly well equipped, the American Institute of Consulting Engineers has sent the following letter to President Wilson:

"The American Institute of Consulting Engineers recently sought an appointment for its committee to present to you, orally, a request for the appointment of some able and experienced engineer to fill one of the vacancies on the Interstate Commerce Commission, with reasons therefor. A hearing having been found impracticable, the Institute has the honor to present its views through the medium of this communication. It is hoped that the argument that must be so briefly expressed here may so appeal to you that you will grant the hearing desired for the committee representing the Institute.

"Membership in the Institute is limited to engineers in independent private practice of such experience and professional standing as enables them to serve their clients in an advisory or executive capacity; therefore the membership consists only of the older or more experienced engineers. Among its members are several of the past presidents of the national societies of civil, electrical and mechanical engineers. The Institute has no candidates to present for office, and is, therefore, enabled to address you from an impartial standpoint, free from personal ambitions, and solely on behalf of the public interests.

"The Interstate Commerce Commission is charged not only with the regulation of transportation rates but also with the regulation and inspection of safety appliances used in our railways, with the investigation of accidents and with the stupendous and expensive task of making a physical valuation of the railways of the country. Consequently many of the duties of the commission are highly technical.

"The leading part taken by the engineer in surveys, location, construction and operation of the railroads gives him special training, skill and acquaintance with their details which would be of the greatest value in the study and decision of the cases that come before the commission, and particularly in the executive work of physical valuation. Heretofore, with but few exceptions, the Interstate Commerce Commission has included no member having previous training or experience in the peculiar and complex problems that have come before it, and the knowledge and training had to be acquired after appointment.

"We submit that while several years are required for a lawyer, politician or other layman to become familiar with the technical details of rail transportation, the engineer, on the other hand, is already acquainted with them. He can examine the details and special facts presented for adjudication without loss of time or unnecessary expense to the public through lack of preparation. With one or more engineers as members of the Interstate Commerce Commission we believe that the duties and responsibilities of the other commissioners would be greatly lightened.

"While the regulation of rates is not wholly an engineering question, the knowledge of the experienced railroad engineer would be helpful and valuable in its consideration. The economic and commercial factors underlying the rate structure are more familiar to him than to any other except the traffic expert.

"Safety appliances and the investigation of accidents on the railways are matters wholly technical and an engineer commissioner would therefore render inestimable service in reviewing the reports of inspectors and giving them proper value. The decisions and recommendations upon the subject of safety appliances, such as block signals and steel equipment, promulgated by the Interstate Commerce Commission would be authoritative and command the respect and confidence of the general public and of the carriers if participated in by well-known engineers.

"The physical valuation of railways is perhaps the most important engineering work now being done in this country. Its cost will be great, it has little useful precedent, and the whole responsibility for the task rests with the commission. While the commission will be aided, of course, by engineering boards and experts, the work will be dominated and directed by the commission.

"The results of this great work will be of vital import to all classes of society, and the well-being of the investor, shipper and laborer is bound up in the outcome. Moreover, the scrutiny that the valuation must undergo before the courts, the railroads and the general public makes it important that the decision of the many elements entering into the valuation should not be left by the Executive entirely in the hands of a commission upon which the engineering profession is unrepresented. We respectfully suggest that an Interstate Commerce Commission including in its membership one or more engineers would arrive at an authoritative and equitable valuation in which all concerned would have confidence.

"While urging the appointment of an engineer on the Interstate Commerce Commission we do not maintain that technical knowledge constitutes by itself a sufficient qualification; a judicial temperament, executive ability and tact are as necessary for a useful engineer member of the commission as for any other. If, therefore, you decide to appoint an engineer, we ask that you select one having these essential qualifications as well as the highest professional attainments. An engineer of the type we ask you to consider will not serve in a subordinate capacity under laymen, but would probably make personal sacrifice for the honor of serving under your Administration as a member of the commission and with the thought of performing a duty as a citizen.

"We repeat that we have no candidate to offer and no motive except to serve your Administration."

FIGHTING OIL FIRES WITH SAWDUST was discussed at a meeting of the American Society of Mechanical Engineers by Mr. Edward A. Barrier. The efficiency of the sawdust, he said, was undoubtedly due to its blanketing action in floating upon the surface of the liquid and thus excluding the oxygen of the air. Its efficiency was greater on viscous liquids than on thin liquids. Sawdust itself was not easily ignited and when it did become ignited it burned without flame and the burning embers did not have sufficiently high temperature to reignite the liquid. It was found that the addition of sodium bicarbonate greatly increased the efficiency of sawdust, as shown both by the short time and by the decreased amount of material necessary to extinguish fires. A further advantage of the addition of bicarbonate of soda was that it decreased the possible danger resulting from the presence of sawdust in manufacturing plants.

Testing Drain Tile and Sewer Pipe

Uniform Application of Load with Hydraulic Platen and Recommendation for Proof Tests of Individual Tile with Portable Machine

By MONT SCHUYLER
Engineer in Charge, Municipal Testing Laboratory, St. Louis

DRAIN tile and sewer pipe, like all engineering materials, may be purchased upon a strictly technical basis, but because of the widely varying nature of the material from which adequate pipe may be made no specification should attempt to place the drain tile made in the various sections of the country upon the same basis. In this respect drain tile is peculiarly different from Portland cement, for it may be readily seen that tile made from an inferior clay would give, if handled properly, satisfactory results under certain circumstances.

Circular Spring Strain Gages

There should be drawn up a basis of understanding between buyer and seller which would not be susceptible of misinterpretation. In other words, engineers should agree upon methods of testing, or at least upon a series of factors which would reduce the indications of one method to those obtained in quite a different manner. Would it not be possible to allow not only the embedment methods, developed by Prof. A. Marston, of Iowa State College, but also the concentrated load method of Professor Talbot and the hydrostatic internal-pressure test? The reasoning involved in this consideration is not complex. Clearly both clay and concrete are far weaker in tension than in compression and, as a result, all mechanical failures are caused by an overstressing in tension of some portion of the pipe. All three methods of testing precipitate failure in tension and if the tests are made in strict conformity with the applied mathematics there may easily be found ratios which will convert one set of readings into another.

LABORATORY EQUIPMENT

Sample testing requires the establishment of a more or less permanent laboratory. The mere size of the testing machine is of small moment if it can be conveniently located between shipping point and work. It is desirable, of course, that it be more or less portable, so that it may be used on projects of no great extent. The machine must be reasonable in price and easy to repair. The advantage of possessing a capable apparatus, with its wholesome psychic effect upon the operator, is in itself worth considerable money.

Clay and concrete products are not rigid in the sense that steel is, but possess a certain plasticity which results in progressive strain under a constant load. This quality produces a variable failure point, dependent upon the loading rate, even if that rate is far below the limit at which impact might be considered as having an effect. Experiments have shown that concrete specimens, twelve months old, when loaded in a testing machine to even as little as one-third of their ultimate strength will, in ten hours, have deformed enough to have released 10 per cent of the stress as indicated by the beam. Similarly, in testing a particular clay tile failure resulted after a few minutes at a constant load which was, perhaps, not more than 60 or 75 per cent of the strength the tile would have shown if progressively loaded.

RATE OF LOADING

These facts are well known, but their effect upon methods of test has not been thoroughly considered. It would seem necessary that the rate of loading should be definitely fixed and that strain should be generated at such speed as would keep the beam of the weighing mechanism balanced. However, the usual method is to actuate the straining mechanism at some convenient and not standardized rate and to weigh this intermittently by adding water to a bucket hung on the scale beam. This process should be changed so that the water would run into the bucket at a definite rate, and straining should be accomplished so that the scale beam will be kept in equilibrium. Professor Talbot's machine—in which levers multiply the weight of sand added to a box—could be standardized by fixing the rate at which the weight is to be applied.

The simplest method of applying the load, and the one that would most quickly appeal to an engineer who had studied the rationale of failure, is undoubtedly by means of concentrated loadings along diametral exterior elements. It is apparent at once that failure will be obtained at the lowest loading, and the very apparent simplicity has much to commend it. On the other hand, practical experience teaches that pipe generally do not run so uniformly that a rigid platen would touch along the entire length of an element. Evidently, then, some method must be devised to secure this uniformity of loading.

UNIFORMITY OF TEST PRESSURE

Plaster of paris is widely used in testing laboratories for this purpose. Experience has shown that compressive tests of concrete made with and without plaster do not differ widely if the compression surface is fairly smooth. On the other hand, speed of testing must be considered, and plaster consumes time not only in hardening but also in making ready.

It is natural, then, that a sand cushion would have many advantages not only in the appreciable saving of time but also due to the fact that a more widely distributed loading is possible. This distributed loading may also affect close parallelism between ditch conditions and the actual test. There is, therefore, an appeal to simplicity in this method which renders it very attractive to many engineers. A close study of earth pressures and ditch failures (see Bulletin 31, Iowa State College, Marston-Anderson) indicated that the strength of the pipe so tested is in substantial accord with the necessities indicated by practice. The method is not unduly wasteful of time, since experiments have shown clearly that the "make ready" is not excessively longer than that found in making concentrated tests using rigid platens and bearing edges.

The sand-cushion method has its drawbacks. There is no certainty that the pressure is uniformly distributed nor that the normal curve of variations in pressure at one testing station is similar to the curve ruling elsewhere. Slight differences in moisture content are impossible of avoidance, and there are no data on hand to show that a difference in sand grading, or even a variance in design of sand box or top bearing block, has no effect. This could never be determined from a series of tests to destruction, since tile vary so much from piece to piece, though an approximate answer might be sought from a critical study of deformation data on the same tile tested under differing circumstances.

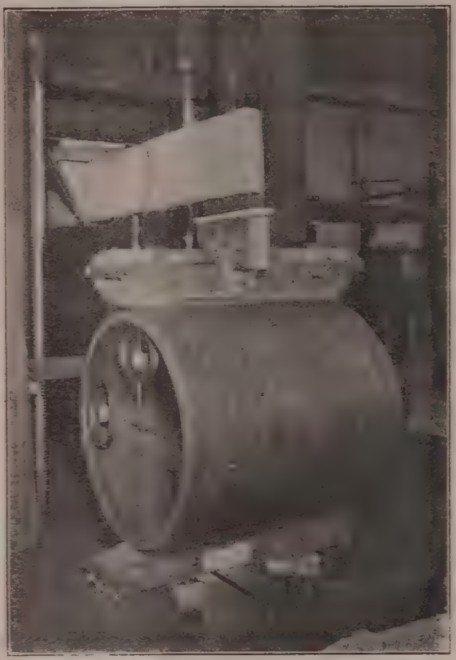
"Spot" Loading

The writer has suggested that perhaps a fair method could be found in a concentration of loading at two diametral spots. This has to recommend it a lower testing load and an avoidance of large uncertainties as to the precise point of application of the load. On the other hand, certain experiments show that though the rigidity of the material tends to distribute the strain, this is not completely accomplished. For the first test on this point a load was applied at one end of the pipe through diametral spots, a piece of yellow pine being used next to the pipe. Six strain gages were set. These gages are composed of a 3-8-in. steel rod attached to a circular spring which carries the other gage point. The stress-strain relationship through this test shows that the end opposite the loading point exhibits a reverse of strain, as might have been predicted.

"Spot" loading evidently must be applied near the center of the length, but the curves show that the center deformations at 2000-lb. load are 25 per cent greater than at the end. This fact would allow the weakness of one end to be masked by the lack of perfect stiffness in the tile. In other words, if the end had been loaded to the same degree as the center, a crack might have started at this point at a lower equivalent load and resulted in a progressive failure. A similar action might be expected from a rigid elemental bearing if the pipe were sufficiently warped to concentrate the loading at the ends or in the center. That this is not infrequently the case is known to all engineers who have examined tile and should not be overlooked in judging either the concentrated spot—or element—loading methods. Of course, the plaster method evades this unfairness, though involving considerable time and labor, and the sand embedment method saves the time waste while entraining uncertainties of an unknown order of magnitude.

Hydraulic Loading Device

There is still another design of platen which, while by no means perfect, affects a compromise between the aforementioned schemes. This design, shown in the illustration, comprises a wooden support to the bearing face of which is fastened a section of woven fire hose partly filled with water and closed at either end with clamps. This platen may be used in any loading machine. It is not as cumbersome as the sand bedding method and need be no more bulky than a properly designed rigid platen. All minor irregularities are approximately equalized by use of this bearing. The flexibility of the partly filled hose is sufficient to insure bearing throughout the whole length of the element, though the area of contact between hose and tile, and therefore the load per inch of length, is not strictly uniform.

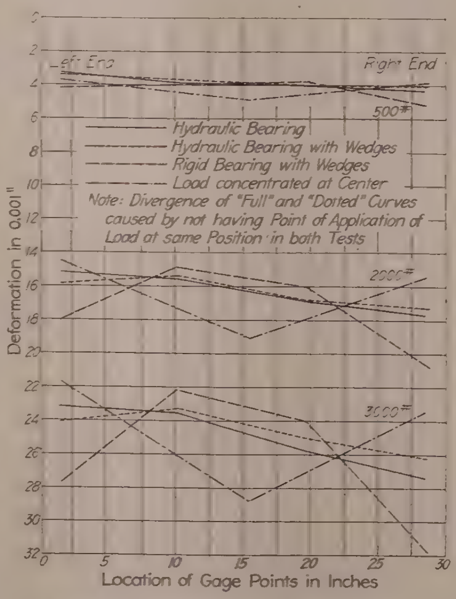


Hydraulic Platen for Tile Tests

The tile upon which the experiments reported in this article were made was unfortunately lacking in strict uniformity of rigidity from end to end. That this is the cause of the irregularities apparent in the curves and that they were not due to the imperfect action of the hydraulic bearing are demonstrated by the dotted curve at deformation, which was obtained by slipping four 3-8 x 5 in. wedges between the hose and the tile, one under each end of the two hydraulic bearings. This manipulation simulated the end distortion so frequently found in tile. The effect of using a rigid platen under similar conditions is shown in the dashed curve.

Internal Loading

Advantages accruing from internal loading are manifest. Cumbrous framing is dispensed with; the reaction of opposing loads being carried by short compression pieces, a lightness of design results which is not only economical but allows of easy transportation. A machine employing internal hydraulic pressure has also been designed and is being successfully used in Kansas City. Whether or not this last machine is of a form which would allow easy testing, the writer cannot say; but the claims of the manufacturer that the weaknesses of the pipe, wherever located, are disclosed are true.



Effects of Bearing on Deformation

Test Every Tile

There is still another point affecting the method of testing which should be given consideration. This is native to the fact that drain tile act individually and, when loaded beyond their resisting ability, fail individually. Furthermore, the complete failure of a single tile involves the failure of the whole line of tiling. It seems a rational conclusion, therefore, since some tile in a given shipment frequently show double the resistance that other similarly appearing tile develop, that tile testing should not be concerned with samples, but that every piece should be subjected to proof loadings and in a manner that will insure that no deficient material would enter the ditch. To do this will undoubtedly mean an added expense; but I have been informed that in a certain instance the failure of a single tile cost more than $1000 even before the tile was located.

To establish proof-testing on a reasonable basis would involve a machine which would be easily portable. Since failure is not sought, the load need not be indicated in pounds, nor with any great degree of accuracy. It has been suggested that a safety factor of 1.3 be adopted, and it therefore seems justifiable that proof-loadings be permitted to generate stresses running to 110 per cent of those expected under the particular ditch conditions. This would allow a possible maximum variation in the truth of the load indications of 10 per cent without serious or unjust results. Furthermore, the load could be applied at two or more diameters and the tile "felt out" for weaknesses. The internal hydraulic pressure test, of course, accomplishes this in one operation. The advantages of this system are obvious enough upon reflection. A tile unable to carry its expected loading will never get into the line and the contractor, knowing this, will soon become more careful in handling his pipe and will accumulate a knowledge of strength appearance which will urge him to sort his material so that the most may be made of the tile in meeting natural conditions.

The manufacturer should suffer to no degree more than at present. In fact, it should benefit the capable firm, inasmuch as this method would supply always a ready market for tile that are not suited to a deep cut but amply adequate for lesser depths. Cracked tile could be proof-tested with the stress plane oriented to develop its greatest strength and then placed in the ditch with this plane horizontal.

Machine for Proof-Tests

Either the "spot" test or the "element" test (using rigid or hydraulic bearings) could be adapted to a "proof-testing" machine, as could the internal-hydraulic-pressure method. The details of the loading and weighing apparatus need not be cumbersome. Toggles, bell cranks, levers or screws could be employed to multiply the manual effort. A spring dynamometer in combination with an Ames dial or a hydraulic diaphragm and Bourdon gage would indicate with more than necessary accuracy the applied load. The men making the test could be supplied with a table correlating fill and gage readings and could in a very few minutes complete a test that would remove all doubt as to the competency of the tile in withstanding the engineer's estimate of the earth loading. A primitive machine of this type has been built and is light enough to be easily carried by one man.

The precise measure of practicability inherent in this scheme cannot be estimated on theoretical grounds. The idea is still inchoate. If the method is not applicable to drainage work, perhaps it can be employed in metropolitan sewer laying, where the loss following failure is great and where competent inspection and engineering supervision are more readily obtainable. It would not be necessary to proof-test each tile if the laying depth were extremely light, but under severe conditions the expense would be justified.

Conclusions

The writer's personal analysis of these theoretical considerations leads to the conclusions here summarized: All failures of tile are the result of overstressing in tension some generally elemental section. When tile vary from piece to piece as much as 100 per cent a demand for a sensitivity of 10 per cent in the load indicating details would seem sufficient. This could readily be obtained, and at no sacrifice of accuracy, by a spring dynamometer and Ames dial gage. Since only the more perfect of the cement tiles allow a continuous contact between a rigid platen and the tile, either a plaster bearing or some flexible platen, such as sand or water, should be used; experiments demonstrate conclusively that the rigidity of the material from which the tile is made is not sufficient to distribute the stress satisfactorily. The simplicity, portability and general behavior of the hydraulic bearing seem to give it a uniquely commendable position. Tile, exhibiting as they do wide variation in strength from piece to piece, should be tested individually to determine their ability to sustain the loading superimposed by particular ditch conditions. This procedure would necessitate a portable machine and perhaps considerable labor in testing, but would amply repay this effort under extreme conditions.

Largest Bascule Bridge

Double-Track, Single-Leaf Span for Baltimore & Ohio Bridge over Calumet River, Chicago, Has Length of 230 Feet

A NEW record for length of a bascule leaf has been established at the Baltimore & Ohio Railroad bridge across the Calumet River in Chicago. The double-track, single-leaf bascule span has a length of 230 ft. on centers—the largest yet constructed. It is notable not only for its dimensions but for the fact that since its completion last February the superstructure has been left standing open with the main trusses in a nearly vertical position without endangering its safety or stability and without prejudice to its future operations.

This span will replace a horizontally revolving span and will occupy so much less space that it will be possible subsequently to build adjacent to it a second double-track bascule span, thus providing for a four-track crossing on the right-of-way formerly occupied by a double-track crossing. The bridge crosses the river at a skew of 50 deg. between its axis and the fender piers, and the span was made so long that the bridge was built square with the abutments and still provides for a clear width of 140 ft. between fenders and perpendicular to them. The details of the substructure were illustrated in the Engineering Record of July 27, 1912, page 94, where there is a diagram of the superstructure which may be referred to. The construction of the substructure was described in the issue of Feb. 22, 1913, page 208.

Tower and Trusses

The superstructure consists of the 230-ft. through-riveted truss bascule span, a 65-ft. approach and a 50-ft. plate-girder tower span, a tower nearly 70 ft. high, and a counterweight truss about 100 ft. long pivoted on the tower and provided with a 2200-ton counterweight and operating mechanism.

The tower and bascule trusses, of very heavy riveted construction, are 31 ft. 3 in. apart on centers and the main trusses are 39 ft. deep. The counterweight trunnions and the pins through the counterweight links are 20 in. diameter, with babbitted bearings in phosphor-bronze bushings. The bascule leaf has a clearance of about 16 ft. above water level, and when it is closed the counterweight is about 2 ft. above train clearance.

Bridge Stands Open a Year

The bascule is of the Strauss standard steel trunnion type, except that the tower has no side braces but acts as a stiff portal, its posts being so wide that the heel of the bascule track is entirely inside of the gusset plate of the tower trusses, which is a deviation from standard practice. The bridge contains 2,800,000 lb. of structural steel, 305,000 lb. of machinery and 1100 cu. yd. of counterweight concrete.

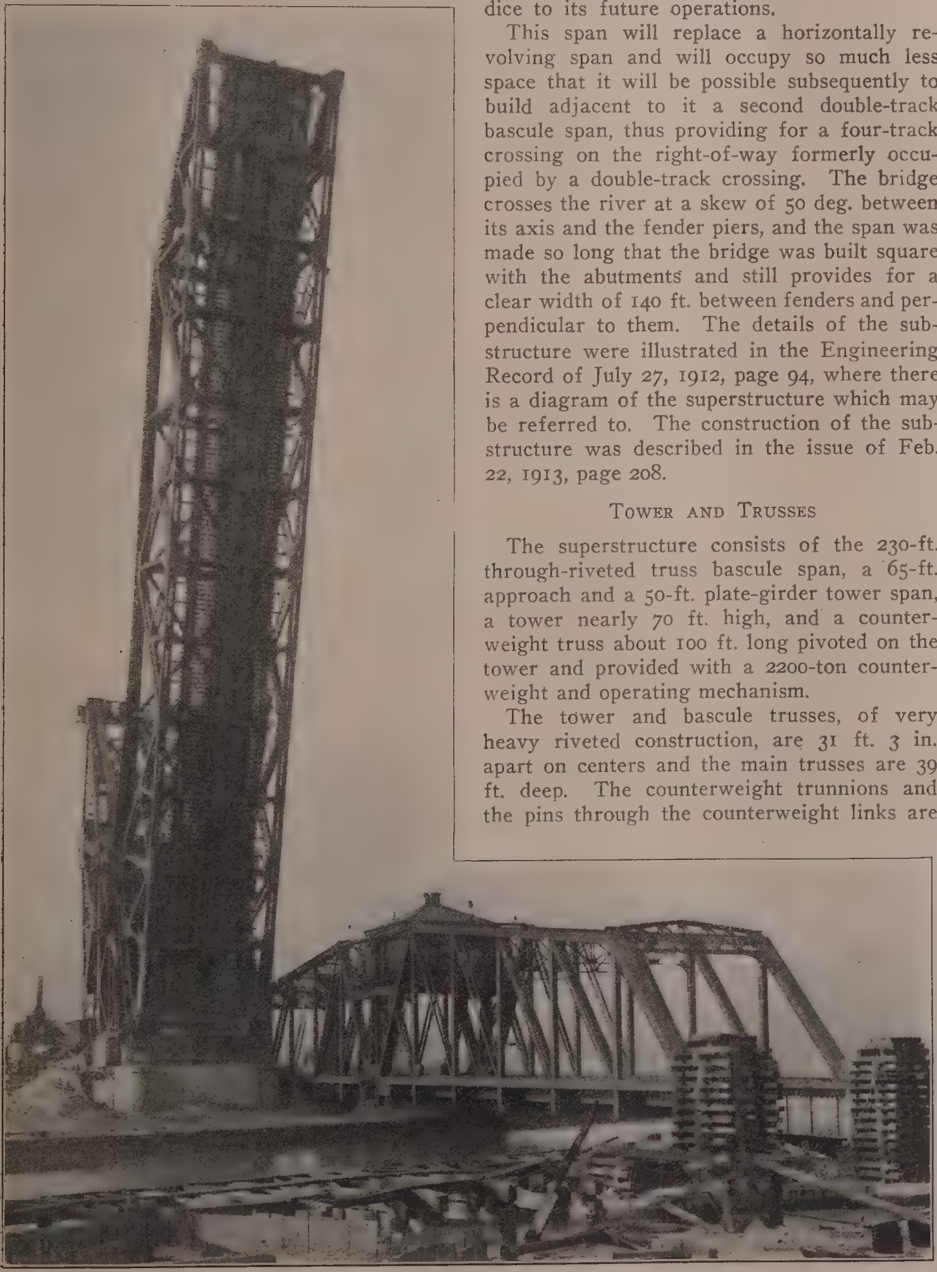
In designing the bridge there was no anticipation that it would be left standing open for a long time; but since its construction it has not been possible to put it in service because the adjacent drawspan of the Lake Shore & Michigan Southern Railroad swings over the front pier of the bascule, and must have clearance for this purpose until it is replaced by a new bridge of the bascule type. This necessitates the maintenance of the Baltimore & Ohio Railroad bascule span in the vertical open position and the continued use of the old swingspan for an indefinite period.

The machinery and gates are so liberally proportioned that no hesitancy was felt in leaving the bridge in this unusual position for fully a year, exposed to any strong winds that may blow.

Test of Operation

After the erection of the bascule it was subjected to thirteen tests, the report of which states: (1) All machinery equipment for moving the bridge was found to engage well and work easily without unnecessary noise. (2) That the bridge was well balanced and that either motor when working alone was fully capable of opening or closing it with the wind blowing from 6½ to 23½ miles per hour diagonally against the structure. Four operations with each motor showed that either motor could raise and lower the bridge in average time of 112 and 86 seconds respectively. (3) The average of four complete operations with both motors gave a raising time of 72 seconds and lowering time of 67 seconds, with the wind blowing from 6.5 to 11.5 miles per hour. (4) When subjected to an unbalanced loading of 8860 lb. of rails the bridge was raised in 83 seconds and lowered in 86 seconds by two motors.

The substructure was designed by Mr. J. E. Greiner, of Baltimore. The superstructure was designed by the Strauss Bascule Bridge Company, of Chicago, under the supervision of Mr. Greiner. The foundations were built by the Foundation Company of New York, and the superstructure was fabricated and erected by the Pennsylvania Steel Company.



Stability of Bascule Leaf Left in Open Position for Months

Deep-Water Piers for Passaic and Hackensack River Bridges

Building Pile Foundations and Depositing Concrete on Them under Water in Cofferdams and in Submerged Forms

THE main-line tracks of the Central Railroad of New Jersey have recently been raised 20 ft. for a distance of about 3 miles near Jersey City, including the crossings of the Passaic and Hackensack Rivers. This improvement was mainly required to provide sufficient clearance for a large proportion of the river traffic and obviate the need of opening the drawspans for nearly all boats. The improvement includes the construction of two steel bridges, several steel and concrete overhead street crossings and many stretches of embankment. The construction of a number of concrete piers in deep water, with pile foundations on difficult bottom, involved driving piles with auxiliary hydraulic jets, depositing concrete under water with bottom-dump buckets in tall submerged forms and special precautions to prevent the formation and accumulation of laitance.

FOUNDATIONS

The two river bridges have together a total of sixteen fixed spans and two drawspans, with a combined length of about 2200 ft. All of them are supported about 18 ft. in the clear above high-water level on concrete piers with foundations on wooden piles; the piles were driven in dredged pits and cut off near the bottoms of the excavations. The excavations were subsequently inclosed by cofferdams protecting the lower part of the concrete. These did not, however, exclude the water.

At the pier sites the water had a maximum depth of 16 ft. at low tide and little current. The bottom consists of from 6 to 10 ft. of rather soft, black clay overlying sand which extends to rock 60 to 75 ft. below the surface. As the Government plans for harbor improvement contemplate dredging to a depth of 30 ft., provision was made by cutting off the piles 28½ ft. below low water in the drawspan piers. In the other piers, where the foundations will not be affected by dredging, the piles were cut off at a higher elevation, nearer the original bottom of the river.

Foundation pits with slopes of about 1 on 2 were excavated at each of the piers by two dredge boats with 5 and 7-yd. dippers working to a nominal depth of 2 ft. below required subgrade. Each dredge handled from 800 to 1000 yd. of material in a twelve-hour shift and delivered to dump scows of from 600 to 1100-yd. capacity. The seven scows employed were towed 40 miles to sea and there dumped.

In some cases considerable time elapsed after the trenches were dredged before the cofferdams protecting them were completed. In some of the Passaic River trenches this interval allowed a large quantity of soft mud to flow into the excavation. This was removed by an 8-in. centrifugal pump before concrete was deposited.

PILE DRIVING

The foundation piles, which were from 30 to 45 ft. long and 8 in. in diameter at the tips, were driven to refusal by a 12,000-lb. Arnot steam hammer and a 7000-lb. Vulcan steam hammer operated in two floating towers with leads about 80 ft. high. In order to drive the piles below the surface of the water the leads were provided with extensions about 50 ft. long, having two bearings about 15 ft. apart, which engaged the ways in the main leads and offset the extensions about 1 ft. in front of them. The extensions were suspended by lines running over sheaves in the top of the tower and operated by a hoisting engine to raise or lower them rapidly at will. The bottom was found to be so hard a little below the surface that a penetration of only about 20 ft. could be secured by the steam hammers alone, and they were therefore supplemented by hydraulic jets.

After the machine was lined into position for each pile a 2½-in. steel pipe about 40 ft. long was operated to make a preliminary hole on the required location for the center of the pile. The top of the pipe was connected by a flexible hose to the discharge pipe of a high-pressure pump which delivered a 200-lb. jet. The pipe was lowered to the bottom and the pressure rapidly pierced through the mud and clay an average distance of 12 ft. to the sand below—an operation usually taking only one or two minutes.

Before the pile was set in the hole it was sharpened to a point 4-in. square. Usually it immediately sank several feet under its own weight and that of its cap, a follower about 30 ft. long, and the steam hammer. It was then driven through the sand at an average rate of 1 in. per blow, until it developed a satisfactory refusal of about ½ in. for fifteen blows.

Each machine drove from thirty to sixty piles in one eight-hour shift. If the tops were driven within 6 in. of subgrade no cutoff was required; if they were more than 6 in. too high, they were cut to subgrade by a circular saw mounted on a hollow shaft 3 in. in diameter with bearings on a full-length 12 x 12-in. vertical timber extending down from the piledriver tower. Little time was required to cut off a pile after the operation was commenced, but considerable delay was occasioned in setting the machine, and only about twelve piles on the average per hour were cut off. The piles were selected and driven so accurately that an average of not more than 2 ft. was cut from each.

COFFERDAMS

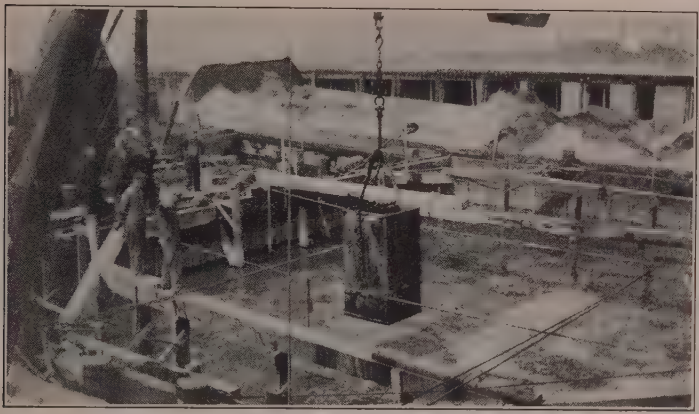
After the piles were driven and cut off they were inclosed by cofferdams. In the deepest water these were made of 12-in. Lackawanna steel sheet piles 45 ft. long, driven by steam hammers between sets of double waling pieces bolted to exterior guide piles. These piles were exposed to a maximum head of nearly 30 ft. at high tide. The clear water above the bottom of the excavation would probably not have contained sediment enough to fill up the joint clearances and make them watertight had an attempt been made to pump out the cofferdam to its full depth. This attempt was not made, however; the cofferdams served to inclose and protect the lower portions of the concrete and only the upper portions of them were pumped out. In shallower water 10 x 12-in. wooden piles with splined joints were used.

The concrete was mixed in a floating plant with a 1½-yd. Ransome machine supplied with cement and aggregate stored on 560-ton deck scows moored alongside and transferred by a clamshell bucket and stiffleg derrick to a small storage hopper delivering by gravity to the charging hopper. The mixer discharged to three 1½-yd. O'Rourke-type steel bottom-dump buckets, which were carefully lowered by the derrick boom to the successive positions under water, and dumped in regular sequence from one end of the cofferdam to the other, thus forming remarkably uniform courses, with irregularities in the upper surface generally not exceeding 6 in. Usually these irregularities were permissible, but when necessary they were cut off by divers.

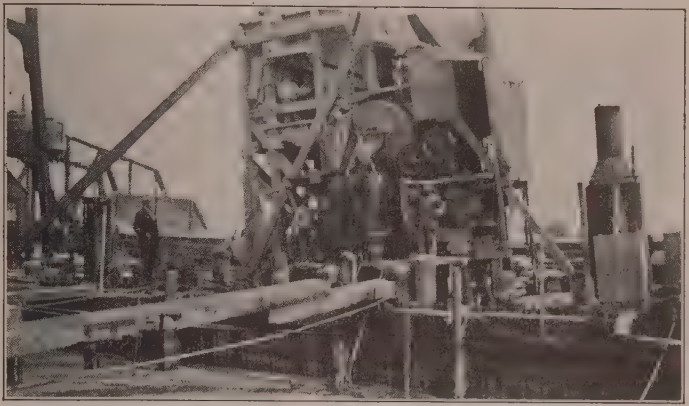
In all cases the bottoms of the piers were

Concreting Part of Hackensack River Pivot Pier

New Piers Built for Passaic River Bridge



Bottom-Dump Bucket for Concreting under Water



Mixer at Center Pier of Hackensack River Bridge

made of concrete deposited without forms around the pile tops over the entire area of the cofferdams. Submerged wooden forms were placed on the footings thus constructed, and the lower parts of the pier shafts built in them by depositing concrete under water in the bottom-dump buckets. After enough concrete was placed at the bottoms of the piers to resist the upward hydrostatic pressure the upper parts of the cofferdams were pumped out and the tops of the piers concreted in the dry in the usual manner.

At the beginning of the work the concrete was made with proportions of 1:2:4 for that deposited under water and of 1:2½:4½ for that placed in the dry. Atlas Portland cement, broken stone and coarse sand with grains up to ¼ in. in diameter were used. A depth of from 4 to 16 ft. of concrete was required to give sufficient weight to resist the uplift, and after the concrete had set as much as 10 in. of laitance was found on top of a 6-ft. course of concrete. Afterward the concrete was made with gravel from ¼ in. to 2½ in. in diameter instead of broken stone, and the amount of laitance decreased to 4 in. for a 16-ft. course of concrete. As the work progressed it was found advantageous to deposit the concrete continuously up to a point about 2 ft. below low-water level, and when this was done the laitance did not collect at any point in the concrete but was continually driven to the surface. After the concrete had set, it was removed by a clamshell bucket or by pumping and by scraping the surface of the concrete.

Pivot Piers

Concrete was deposited over the full area of the cofferdams to a depth of about 6 ft. for the center piers of the drawspans. After this concrete had set five or six days submerged forms were set up on it and more concrete was deposited for the lower parts of the pier shafts. The sides of the forms were made of large wooden panels, loaded with old rails; they were lowered to position by one of the three large steel floating derricks employed on the job and adjusted and connected by divers, who placed them against the sides of the cofferdam. For the Hackensack bridge two courses of forms making a total height of 28 ft. were set at once and concreted under water. Subsequent examinations by divers, after the forms had been removed, showed that the concrete was filled in at the offsets between courses and that the exterior surface was sound and regular.

In the cofferdams for the shorter piers special eyebolts were provided in the wooden sheet piles before the latter were driven. Through snatch blocks attached to the eyebolts lines were passed to the hoisting engine to pull the buoyant forms down into position. This method proved satisfactory, but was not applied to the steel cofferdams, because the piles there were not provided with connections for the pulling lines.

Bottom-Dump Buckets

Rectangular steel buckets of 1½-yd. capacity were used for depositing the concrete under water. The sides of these buckets are about 5 ft. high, continuing about 2 ft. below the hinges of the double-flap drop-bottom doors to allow the doors to revolve into almost vertical position when the bucket was seated on the bottom. At each end of each flap a shoulder projects through a radial slot in the side of the bucket and engages an exterior bridle chain. These are connected to a second bridle which reaches transversely across the top of the bucket and engages a hook at the short end of a long and heavy lever. The hook is riveted to a vertical rod sliding freely through the high rigid bail of the bucket and carrying at its upper end a ring which is clevis-connected to the hoisting tackle. When the tackle is slack the pivoted hook is free to drop down and engage the bridle and when the bucket is hoisted the strain on the tackle closes the doors and holds them in position until the bucket is again seated on the ground and the hoist lines become slack, allowing the heavy, long end of the lever to trip the engagement with the bridle and release the doors automatically. When the bucket is hoisted by the bail it slips freely clear of the concrete depositing it on the bottom and leaving it undisturbed by the water, no matter how deep this may be.

The buckets were handled very accurately and were so satisfactory for depositing submerged concrete that the divers found it uniformly placed in layers about 2 ft. thick, with only small irregularities in the upper surface. It was found that when the buckets were not fully submerged their operation was not as satisfactory as in deeper water, thus indicating that the weight of the water on top of the bucket is a desirable factor.

Dredging for the first pier of the Passaic River Bridge was begun in June, 1912. The substructure was completed and the erection of the steelwork was started early in August, 1913, and the new line was put in service on Oct. 5.

Removing the Temporary Trestle

The temporary by-pass trestle contained about 4000 spruce piles from 25 to 30 ft. long and 1,000,000 ft. b.m. of timber, all of which will be salvaged. The rails were stripped, the ties removed and the stringers and caps unbolted and taken off by the floating derricks. The piles are being pulled at the rate of about ten per hour by the two floating pile drivers equipped with eight-part tackles, which are attached to the piles by an ordinary chain sling. This rig has pulled yellow pine and oak piles without much difficulty, but when applied to the spruce piles in the by-pass it broke them off. It was therefore supplemented by a 2-in. hydraulic jet of 200-lb. pressure, that was first run down alongside to loosen the pile before the strain was put on the tackle.

The work was done under the direction of the engineering department of the Central Railroad of New Jersey, of which Mr. Joseph O. Osgood is chief engineer; Mr. A. E. Owen, principal assistant engineer, and Mr. J. J. Yates, bridge engineer. Mr. L. M. Hannaford was the resident engineer on the work. Mr. H. R. Wheeler was the chief engineer and Mr. W. Malcolm superintendent of construction for the contractor, Henry Steers, Inc., of New York.

Adding Artificial Turbidity to Water

Hastening the time for floc formation and sedimentation of Lake Michigan water by the addition of an artificial turbidity when the natural turbidity is low is indicated in experiments made recently by Mr. J. R. Davies at Evanston, Ill., and reported as thesis work at Northwestern University. He also found that floc formed more rapidly on addition of lime or aluminum sulphate when the turbidity was high than when low.

Washed and calcined diatomaceous earth was added to filtered water to produce turbidities up to 250 parts per million. Filtered water was used to eliminate a third variable. Treating eleven samples with 3 grains per gallon of lime each the floc appeared as follows:

Turbidity	0	25	50	75	100	125	150	175	200	222	250
Minutes for the first floc	15	15	12	11.5	10	8	8	7	6	6	4.5

With 1.5 grains per gallon of aluminum sulphate the results were:

Turbidity	0	25	50	75	100	125	150	175	200	225	250
Minutes for first floc	9	8.5	8	7.5	7	6	5.5	4	4	3.5	3.5

An Elevated Village for workmen on the construction of the Rogers Pass tunnel of the Canadian Pacific Railway is to be built by the contractors, Foley, Welch & Stewart, according to a recent consular report from Vancouver. To avoid drifting snow the houses will be built 8 or 10 ft. above the ground level and connected by elevated bridges.

American Road Builders' Association

Abstracts of Some of the Papers Presented at the Annual Convention in Philadelphia, December 9-12

Unit Price, Lump Sum and Percentage Work

By H. C. HILL
Lane Construction Corporation, Meriden, Conn.

CONTRACT work has everything that percentage work has and something in addition—an incentive to accomplish results in the most economical manner and with the least expenditure of energy. An attempt has been made to instill incentive into percentage work by establishing a price on each unit of work and paying a bonus on a sliding scale if the work is done at a cost less than first agreed upon. This is a very delusive point, and those familiar with the variable factor in cost data will readily see the futility of this. It is the percentage that gives the contractor his profit and not the bonus.

ADVANTAGES OF UNIT PRICES

No reliable experienced contractor will bid as low on a lump-sum proposal as he will on a unit-price contract, for all construction work is more or less of a gamble and the risk in the lump-sum plan is greater. Under the lump-sum method changes in contract quantities have no effect upon the amount of money received by the contractor. The theory of the unit-price method is very simple—a contractor is paid for just what he does and does just what he is paid for. Nothing could be more equitable. However, it has its imperfections, but they are not serious. Its weakness lies not in itself but in the hands of inexperienced men, incapable, through ignorance, of properly preparing unit quantities. This weakness causes unbalanced bidding. Engineers should ask themselves if an unbalanced bid is any worse then an unbalanced schedule prepared by engineers. If engineers were as careful not to leave any loopholes in preparing estimates for contractors to bid on as they are in making out specifications for them to do the work by, unbalanced bidding would cease. With unit prices changes may be made while work is in progress with the least possible chance of any dispute, and, as a rule, at a less cost than by the lump-sum method. It is the nature of many people not to do the task set before them in as careful, thorough and complete manner as should be done. In this respect contractors, and more particularly their employees, are not unlike others. Therefore any method of payment that will remove the temptation not to do good work and make it an object to do work in a careful manner will insure successful results. It needs only a superficial examination of a lump-sum contract to see that not only is the incentive to do faithful work absent but there is also a premium for not doing it.

Engineer, Inspector and Contractor

By FREDERICK L. CRANFORD
Frederick L. Cranford, Incorporated, Brooklyn, N. Y.

THERE is a noticeable difference in the number of inspectors employed on public and private work, political considerations being still visible as a cause for this difference. A large number of inspectors are not helpful, but practical skill and experience are necessary to proper inspection. It has been our experience that a small number of inspectors have not only been of assistance to hold within proper limits overambitious foremen, but have been of great assistance in matters of more importance, namely, the safety of the work, the public and the workman. These questions have received too little attention in the past, as the percentage of preventable serious accidents on public work has shown. Some believe it to be as high as 50 per cent, while the percentage of preventable minor accidents is much greater.

OBJECTIONABLE CONTRACT CLAUSES

A little less politics and more responsibility will strengthen the inspector in our organization, just as it has benefited the engineer. It may sound somewhat strained to talk about curbing politics with regard to inspectors when contractors are so free from such contamination; but there is no doubt that political considerations were the important cause of writing into our public-work contracts and specifications the usual iron-bound clauses in which the contractor surrenders any and all rights he may have as a citizen or under the laws and constitution of the State and nation calculated to hold him, his successors, assigns and his heirs to perform without cost any foible or eccentricity of the engineer and of which the engineer is the sole judge.

Let me read two clauses from contracts for the construction of the New York Subway: "The specifications and contract drawings hereinafter mentioned and taken in connection with the other provisions of this contract, are intended by the Board to be full and comprehensive and to show all the work required to be done. But in a work of this magnitude it is impossible to either show in advance all details, or to precisely forecast all exigencies. The specifications and contract drawings are to be taken, therefore, as indicating the amount of work, its nature and the method of construction so far as the same are now distinctly apprehended. . . . If in the specifications or contract drawings or in the provisions of this contract, any detail or other matter or thing requisite for such construction be not mentioned; nevertheless the same is deemed to be included, and the contractor hereby undertakes to do the same as part of his work hereunder. And it is expressly agreed that the price to be paid to the contractor as herein prescribed includes full compensation for every such detail, matter and thing."

"To prevent disputes and litigations, the engineer shall in all cases determine the amount, quality, acceptability, and fitness of the several kinds of work and materials which are to be paid for under this contract; shall determine all questions in relation to the works and the construction thereof, and shall in all cases determine every question which may arise relative to the fulfilment of this contract on the part of the contractor. His determination and estimate shall be final and conclusive upon the contractor, and in case any question shall arise between the parties hereto, touching the contract, such determination and estimate shall be a condition precedent to the right of the contractor to receive any money under this contract."

Could there be a greater compliment paid to a man than this engineer pays to the contractor that tackles such a job? I'll answer that myself—yes, the compliment to the engineer paid by the contractor when he signs that contract.

A specification for any given piece of work has an underlying and fundamental meaning. It is a description of how to secure the construction with given materials of the best character of work obtainable and the relation which we bear to one another is largely governed by it. If the meaning be ambiguous and the requirements vague, it is very easy for the relations to degenerate into an effort to see how much each can get away with. A greater simplicity and a larger measure of fair dealing would seem to me to point to a great possible improvement.

While the unlimited authority given to the engineer to interpret and finally determine the meaning of the contract provisions is in practice nullified, first by enlarged estimates to meet the risk of an improper decision and, second, by the enforced decisions of our courts holding that this power is really not conclusive, still some method should be devised which would not only limit this seeming arbitrary power of the engineer to make or break a contractor, but would also retain his authority to control and direct the work.

Public work in the United States is largely now upon a very high plane of accomplishment. Our great private work has been heretofore free from scandal and corruption, but curiously our organization (that is, the contract system, or the engineer, the inspector and the contractor) is in this particular I believe to-day in greater danger from these causes upon private work for great corporations than upon public work.

The work of the Panama Canal is an illustration, and the only great illustration on which our organization did not work together. My belief is that it only proves the rule as an exception and that the elimination of the contractor in that instance was proper and best. The twentieth century is just well started and looms big with opportunity, for we have done and are doing great work.

Testing Road Materials

By PREVOST HUBBARD
In Charge of Division of Roads and Pavements,
Institute of Industrial Research,
Washington, D. C.

INDIVIDUAL tests required by specifications for bituminous road and paving materials may serve one or more of the three following purposes: (1) They may directly indicate the suitability for a given use of the material specified. (2) They may serve as a means of identifying the source of a material, or even the material itself. (3) They may serve to control uniformity in the preparation or manufacture of a material.

The first of these purposes is undoubtedly the most important and is usually the only one considered by the lay mind. In the case of bituminous material, this purpose is only partly accomplished by a comparatively few tests. As examples may be mentioned tests of consistency, such as the penetration test, the float test and the test for viscosity. Such tests can only be of maximum value, however, when applied to a specific type of bituminous material and when considered in connection with other tests, which by themselves may not directly indicate suitability. Thus, for a certain type of bituminous concrete pavement the proper penetration limits at 25 deg. C. for a California asphalt may lie between 7 and 9 mm, while the proper penetration limits for a fluxed Bermudez asphalt, to be used in exactly the same type of pavement and under the same conditions, may be from 14 to 16 mm. It is evident that to attempt to cover the penetration limits for both materials under one specification would be useless. In the first place, such test limits as 7 to 16 mm are so wide as to insure but little uniformity in different lots of the same material; and, in the second place, an entirely unsuitable material of one class might be supplied under the maximum test limit of the other class. The fallacy of blanket specifications, which have already been advocated to a considerable extent, is thus easily demonstrated.

If a penetration test is essential under the conditions just mentioned, it is apparent that recourse must be had to separate type specifications; and if this is so the specifications must contain either tests or test limits which will describe certain peculiarities of the type specified that are not common to other types.

Identification Tests

This brings us to a consideration of the use of tests as a means of identification. There are a number of such tests, among which may be mentioned specific gravity, melting point, solubility in carbon disulphide, fixed carbon, etc. So far as the usual test records are concerned, the specific gravity of a bituminous road or paving material is one of the most important characteristics used to determine its identity, and this is particularly true if its specific gravity is considered in connection with the consistency of the material and sometimes its solubility in carbon disulphide. Thus a bituminous material with a specific gravity of 0.99 and penetration of 7 mm at 25 deg. C. must be a blown product. Fluid consistency and high specific gravity of 1.25 in a tar serves to identify it as a coal tar, and the identification is strengthened if its solubility in carbon disulphide is as low as 75 per cent.

High fixed carbon in most asphalt cements produced from Mexican petroleums is a distinguishing characteristic. Relatively low fixed carbon in good asphalt cements of the same consistency produced from California petroleums serves to differentiate them from the Mexican products. Here, again, the necessity or desirability of different test limits is apparent, for if the amount of fixed carbon yielded by a California asphalt cement were as high as the 16 per cent often found in Mexican asphalt cements, indications would point very strongly to injury of the former, due to excessive temperatures having been employed in the process of manufacture.

Uniformity in Manufacture

This leads us to the third purpose for which tests may be made to serve—control of uniformity in the preparation or manufacture of a material. Among such tests may be mentioned those for determining flash point, loss by volatilization, distillation, solubility in given grades of paraffin naphthas and solubility in carbon tetrachloride. Practically all of the other tests previously enumerated may also be made to serve this end. No one by itself will, however, necessarily accomplish this purpose, no matter how close the test limits are drawn. This is mainly due to the fact that products of innumerably varied and complex characteristics may be produced from a given crude material by modifying the methods of manufacture.

By direct distillation of a given crude petroleum an asphalt cement of 10 mm penetration can perhaps only be produced by the removal of a considerable amount of distillate and the application of comparatively high temperatures. If distillation is discontinued in an intermediate state, however, and the blowing process employed, an asphalt cement of the same penetration may be produced with the removal of much less distillate and the application of a lower maximum temperature. In the second case the resulting product, while of the same consistency as the first, may have a lower specific gravity, a higher melting point, a greater penetration at low temperature, and a less penetration at high temperature.

Other properties such as fixed carbon, naphtha soluble bitumen, loss by volatilization, etc., may also be different. In such cases, control or assurance of uniformity in different lots of material must depend upon a number of tests, the interrelation of which is clearly understood, and for which suitable limits are specified.

Discriminative Tests

Discriminative tests and specifications are perfectly proper and often desirable, if used in the right manner. When a given type of bituminous material has a single characteristic property which distinguishes it from other types, test limitations of this property may be so drawn as to make a specification discriminative. The status of such specifications is not usually difficult to ascertain. Discrimination is, however, sometimes secured by the use of a combination of two or more test limitations, the significance of which is only apparent under the close scrutiny of one who has an intimate and comprehensive knowledge of all types of bituminous materials. Specifications of this class may, as a whole, absolutely eliminate competition, although no single clause in the specifications could be criticised from this standpoint.

If competition is eliminated by a single specification, as is sometimes advisable or even necessary in order to insure a satisfactory product, it may often be restored by the use of two or more specifications which will serve as alternatives. When this is done, two or more types of bituminous materials will be specified, which are of equivalent value insofar as their suitability for a given use is concerned. Thus while different test limitations and sometimes different properties are covered by the different specifications, each particular combination of test limitations and properties, constituting a given specification, will be considered as equivalent.

While the average highway engineer will not find it practicable or even necessary to become a highway chemist, he should nevertheless possess as a part of his practical working equipment some knowledge of the chemical and physical properties of bituminous materials and methods of testing them. A lamentable lack of such information is apparent in many highway engineers who, in other branches of their profession, are thoroughly capable and efficient.

Allowable Variations

One other point may be mentioned regarding the preparation of specifications which is directly connected with test limitations, and this is the matter of allowable variations in results which may be looked for from different chemists and different laboratories. In the first place, it should be remembered that at the present time there are comparatively few standard methods for making tests which have been generally adopted. Variations in results are frequently attributable to variations in methods of testing. It is, therefore, good practice to include in or as a part of specifications descriptions of the methods to be employed in testing. This is especially true where specifications are to be widely used. A certain variation in results may be expected also from what is termed the personal equation. Thus in the ordinary volatilization test a variation of 1 per cent in results obtained upon a material losing 15 or 20 per cent would be perfectly reasonable, while in a material losing 2 per cent it would be an inexcusable variation.

Convict Labor in Road Construction

By **JOSEPH HYDE PRATT**
State Geologist of North Carolina

In serving his sentence a convict is paying a debt he owes the State for infringements of the laws, and when he has served this sentence he has paid his debt and should be in a position to become a good and valuable citizen. The attitude of the State toward a convict should be corrective and not vindictive and there must be an incentive before good work can be expected from most convicts.

Plan of Organization

I submit a plan for the treatment and organization for work of the convict. That the men who have been convicted and sentenced for the first time shall not be required to wear stripes or have their heads shaved. There could be three classes of convicts: Those in the first class, who are not required to wear noticeable uniforms; those in the second class who are required to wear a distinctive uniform but not stripes, and those in the third class who are required to wear stripes and, if necessary, have their heads shaved.

The organization of this convict labor for road construction will be of two distinct methods depending upon the classes of convicts used. The first class, or "honor" men, should be worked without guards and without stripes. The second and third classes should have armed guards. The men of the third class would wear stripes and work under guards with guns, and the worst men of this class might have to be worked in stockades in breaking rock or doing similar work. Those of class 2 would be worked under guards with or without exposed firearms, as the case might be. At night the convicts of class 3 would be in chains and under armed guards, while those of class 2 would not be in chains but under armed guards.

The convicts in the first method of organization representing class 1 or honor men would be divided into three groups, if the camp were of sufficient size, according to the work that the men are capable of doing. In the first group would be the most efficient men of the camp, of whom would be expected a certain definite amount of work. Knowing, then, what each group of men is capable of doing on an average as a day's work, the foreman of the road work could estimate what each group should easily be able to do in a certain time; and then, if the group were able by especially energetic work to accomplish more than the required amount, the men of that group should be allowed as a bonus a certain percentage of the value of the extra work that the group accomplishes, this to be paid in money and divided equally among them. The first group should be allowed 50 per cent, the second group, 40 per cent, and the third group, 30 per cent of the value of the extra work. The men of the first class would also receive a commutation of time.

Colorado, Oregon and Washington are States that are using convicts of class 1 in public road construction, but as yet are not using convicts that will correspond to class 2. Virginia is working her convicts as class 2. At nearly all the Virginia convict camps there are a certain number of "trusties" that are trusted absolutely. The difference in the cost of the work is all in favor of Colorado, Oregon and Washington. Georgia has class 2 without stripes and class 3 with stripes.

Arrange for the convicts to built the roads and the roads will rebuild the convicts.

What " the Mayor's Eye " Has Seen in Three and One-Half Years

THE office of the commissioners of accounts in New York City has been termed "the mayor's eye" because it was designed to inform the mayor of the workings of the thirty-four departments of the city government, employing 80,000 persons and disbursing $250,000,000 a year. Its recent report indicates that its activities have developed from the exposure of dishonest officials to a broad study of the waste resulting from extravagance, poor judgment and inefficiency, so that the accountants are now known as "municipal experts" instead of detectives. The 400 minor reports submitted since Jan. 1, 1910, show the growth of the scope of the department. The commissioners state that the work is now concentrated on introducing uniform systems of accounting, providing for much-needed inspection, and regulating the size of the working organizations, although retention of fees, neglect of work and incompetency are dealt with as vigorously as ever. But the aspect of the force is becoming that of an efficiency organization, suggesting, in its recognition of the mayor's wide administrative responsibility, the present trend toward the commission form of government. This expansion is evidenced in an extensive plan for the reorganization of the borough of Queens. The existing conditions with respect to organization and personnel, functions, forms, procedure and physical accomplishment were determined. This information formed the basis for studies which resulted in the adoption of a plan of functional reorganization as a model to control the work. The plan contemplates a logical grouping of functions and the establishment of definite responsibility and authority under three general divisions, general administration, engineering and maintenance.

Its application to existing force and work was undertaken by selecting the maintenance forces for first attention, which involved the detailed planning of a comprehensive cost system; the concentration of effort and assumption of authority over forces in the Fourth Ward, to facilitate the experimental application of the plan; the preparation of a large amount of statistical data necessary for the exercise of judgment and control of work assignment; and the establishment of control over material, supplies and equipment. The results so far are very encouraging and extension of the plan will be made.

Sluicing Sand and Gravel in Steel-Lined Flumes

Successful Use of Old Band and Circular Saws Where the Rapid Wear of Unprotected Wood Had Made the Cost Prohibitive

IN the pits of the Tacoma Sand & Gravel Company, which are located at Steilacoom on Puget Sound, about 10 miles south of Tacoma, Wash., experimenting has been done to discover an economical, smooth lining for flumes subject to very heavy wear. The conditions at this plant are such, it is reported, that an ordinary 1-in. board in the flume bottom will wear through in about two days, and the cost of maintaining any of the ordinary forms of flume block paving has proved prohibitive. The unusual severity of the wear is caused by the fact that the flume grades have been kept down to 8 and 10 per cent., and about 1.6 cu. yd. of sharp material are carried for every 1800 gal. of water pumped. The advantage of this is that a daily output of 1800 cu. yd. is maintained with a pumping equipment which is considered comparatively light for the yardage handled.

Sand Bank and System of Steel-Lined Sluicing Flumes

The deposit lies at the water's edge in a bank rising to an elevation of 240 ft. above mean low water, and all buildings, bunkers and loading dock are supported on piles in deep water. Flumes from the pit discharge into separators which feed a 500-cu. yd. gravel bunker and a 350-cu. yd. sand bunker. The bunkers discharge through twenty under-feed gates into 4-yd. bottom-dump cars which can be hauled to the end of the dock and emptied into scows at the rate of 6 cu. yd. per minute. Water is supplied to the pit from the Sound by two duplex compound steam pumps—one with 10 x 16 and 12 x 18-in. cylinders, the other with 8 x 12 and 10 x 16-in. cylinders. From these pumps a 10-in. riveted steel pipe line runs to the pit, paralleled by an 8-in. auxiliary line. The average lift of the water is 100 ft., and at this head these pumps normally deliver 1800 gal. per minute. This delivery for 18 or 20 hours per day is sufficient to bring to the bunkers the full capacity of 1800 cu. yd.

Three separators are in use, fed by three 130-ft., 12 x 12-in. flumes which branch from a main flume 24 in. wide and 12 in. deep. This main flume, which runs to the face of the pit, has a length of 100 ft. and is fed by numerous branch flumes of equal depth and 15 in. in width. From these branches 12 x 12-in. laterals are laid to attack the bank at any desired point. All these flumes in the pit are on an 8 per cent grade, the three separator lines having a 10 per cent grade.

With the low velocity of water and the very heavy percentage of suspended matter the wear on the bottom of these flumes was so great that at first no material could be found which would fulfil the requirements of hardness and cheapness with a low coefficient of friction. Finally the expedient of buying old bandsaws from the lumber mills was adopted, and the use of these saws to take the wear met with success, it is said, from the start.

The flumes are built of 1 x 12-in. rough lumber, chiefly in 6-ft. sections, and this construction lends itself readily to the use of bandsaws, which come in 10, 12 and 14-in. widths. In the 12 x 12-in. flumes a single saw blade is laid in the bottom and a three-cornered wooden strip nailed over it at the corners to hold it in place. In the 24-in. flume circular saw blades, sheared to the proper widths, were used in the same way.

The bandsaws are usually 12 gage, while the circular saws come in 6 or 8-gage thicknesses. As the material is oil-tempered tool steel, it is too hard to be recast successfully, and therefore has little scrap value. Discarded saws were bought at prices ranging from 0.25 to 0.50 cent per pound and are believed to last three or four times as long in the flume as ordinary structural steel. In the flumes on 10 per cent grade it is said that the 12-gage steel normally passes 10,000 to 12,000 cu. yd. of material before being worn out.

UNDERGROUND FIRES along the Champlain barge canal, of three years' duration, have been attacked by a force under Duncan W. Peck, superintendent of public works, New York State. The area affected extends on either side of the canal just north of Dunham's Basin, Washington County, a distance of 3 or 4 miles. The surface clay overlays 5 or 6 ft. of peat, into which the fires have burned for from 2 to 5 ft. Where the peat has been burned for a sufficient time, the surface falls in; a person may even sink several feet through seemingly solid ground into the burning ashes.

The State forces have excavated a trench about 3 miles long to a depth of 4 to 6 ft. and keep it filled with water from the canal, expecting that the fire will burn itself out. Much of the wooden sheet piling driven along the canal will have to be replaced. At many points the top of the wash wall has fallen in 3 or 4 ft. below the top, and the area back of the canal will have to be refilled and a new wall constructed.

American and British Road Tars

Comparative Analyses to Determine Composition of Several Different Products

By Major W. W. CROSBY
Consulting Engineer, Baltimore, Md.

APPARENTLY superiority of British tarred roads over work of similar character in America leads one to ask whether this excellence comes from superiority of the tar used or from this and other reasons. During a visit to England this year the writer obtained a sample of British tar, said to be in general use and responsible for many of the good results noted. Analyses of this tar and the American product have been made under identical conditions.

The British tar was a "dehydrated" by-product of the manufactures of coal-gas and of coke. Table 1 shows the analysis of this tar and of a raw "coke-oven tar," a "refined coal tar" and a "refined water-gas tar" in common use in this country.

Some time ago the writer published an article corncerning the changes noted in a tar exposed to traffic, in which he referred to the practical difficulty with the "free carbon" element in analyses of pitchy material extracted from the road after use and then suggested a secondary analysis before use of characteristic materials containing over 5 per cent of "free carbon" so as to supply records and data from which it might be possible to learn much. He therefore submits Table 2, showing the relative analyses on a "free" or "free carbon" basis.

Confirmation of the observations that the British tar proves better for road work seems to be had from the analyses. It seems to become hard and brittle less quickly and the tests show that it actually gives a softer residue from the evaporation tests and one which changes less under them than do the American tars. It is true that the variations of temperature on the British roads are less and the extremes of temperature there are nearer the mean than under American conditions.

It will be noted that from the British tar an unusually high proportion of distillate is obtainable between 170 and 270 deg. C. when compared with the results from American tars. The presence of the abnormal amount of this fraction has probably something to do with the softness of the residue after evaporation and (assuming this evaporation test to simulate at least an accelerated weathering test) with the absence of the tendency, common in American tars, to become quickly hard and brittle on the road in cold weather. But it is rather curious to note that this same fraction contains the "naphthalene" and the "naphthalene or creosote oils," while certain chemists have expressed themselves to the effect that "naphthalene" is undesirable in tars for road work.

The writer is indebted to Penniman & Browne, analytical chemists, of Baltimore, for the analyses and for much assistance in the preparation of these data.

TABLE 1—ANALYSES OF BRITISH AND AMERICAN TARS

Analysis	British tar ("dehydrated") (1)	British tar ("dehydrated") (2)	American coke-oven tar (raw) (1)	American coal-tar ("refined") (1)	American coal-tar ("refined") (1)	American water-gas ("refined") (1)
Specific gravity	1.201	......	1.235	1.213	1.223	1.183
Free carbon (insol. in CS_2)	20.22%	......	18.29%	15.7%	20.11%	0.44%
Fixed carbon less free carbon	6.63%	......	10.24%	10.1%	10.39%	23.77%
Viscosity—						
At 100° C. (Engler)	34.3 sec.	......	30 sec.	40 sec.	41 sec.	155 sec.
At 25° C. (Lunge)	3.8 sec.	......	4 sec.	14 sec.	4 sec.	966 sec.
At 25° C. (Hutchinson)	5.4 sec.	......	......	......	......	......
At 25° C. (Crosby, Plunger No. 12, load, 4 grams)	52 sec.	......	......	......	......	......
At 25° C. (Crosby, Plunger No. 12, load, 0.5 grams)	6 sec.	......	......	......	......	......
Loss on evaporation at 105° C., 3½-in. dish, 21 hours	14.70%	......	21.95%	17.0%	23.5%	4.45%
Penetration of this residue at 4° C.	35	......	5	1	Too hard	12
Penetration of this residue at 25° C.	Soft	......	42	65	15	110
Melting point of this residue	17° C.	......	55° C.	43° C.	61° C.	34° C.
Loss on evaporation at 170° C., 2½-in. dish, 5 hours	15.15%	......	22.05%	24.5%	24.2%	21.55%
Penetration of this residue at 4° C.	29	......	Too hard	Too hard	Too hard	Too hard
Penetration of this residue at 25° C.	Soft	......	10	Too hard	13	Too hard
Melting point of this residue	21° C.	......	58° C.	74° C.	53° C.	89° C.
Distillation—						
Initial temperature of distillate	164° C.	155° C.	98° C.	150° C.	145° C.	226° C.
Room temperature to 105° C.	0.0%	0.0%	0.5%	0.0%	None	0.0%
105° to 110° C.	....	0.0%	....	....	....	....
105° to 170° C.	0.4%	Trace	2.0%	1.4%	1.3%	0.0%
170° to 225° C.	*3.4%	6.0%	9.8%	2.9%	7.0%	0.0%
170° to 235° C.	....	9.0%	....	....	....	....
225° to 270° C.	*12.7%	14.0%	20.0%	15.0%	21.4%	2.0%
235° to 270° C.	....	11.0%	....	....	....	....
270° to 300° C.	**6.7%	6.0%	23.6%	30.0%	29.9%	5.5%

(1) According to methods proposed by special committee, American Society of Civil Engineers.
(2) According to methods proposed by sub-committee of committee D-4, American Society for Testing Materials.
* Practically all solid (naphthalene) at 25° C.
** 25% solid at 25° C.

TABLE 2—ANALYSES ON A FREE CARBON BASIS

Analysis	British Tar (1)	British Tar (2)	American Tar (1)	American Water-Gas Tar (1)
Specific gravity	1.148		1.124	1.144
Free carbon (insol. in CS_2)	None		None	0.43%
Fixed carbon less free carbon	13.69%		12.77%	23.22%
Viscosity—				
At 100° C. (Engler)	15 sec.		15.7 sec.	113 sec.
At 25° C. (Engler)	313 sec.		172.8 sec.	
At 25° C. (Lunge)				550 sec.
At 25° C. (Hutchinson)				
At 25° C. (Crosby) (Plunger No. 12, Load, 0.5 grams)	130			
Loss on evaporation at 105° C., 3½-in. dish, 21 hours	29.90%		38.20%	8.65%
Penetration of this residue at 4° C.	9		Hard	10
Penetration of this residue at 25° C.	54		Hard	79
Melting point of this residue	30° C.		40° C.	33° C.
Loss on evaporation at 170° C. 2½-in. dish, 5 hours	35.25%		45.00%	24.10%
Penetration of this residue at 4° C.	Hard		Hard	Hard
Penetration of this residue at 25° C.	9		Hard	Hard
Melting point of this residue	42° C.		81° C.	70° C.
Distillation—				
Initial temperature of distillate		130° C.	128° C.	248° C.
Room temperature to 105° C.		0.0%	None	0.0%
105° to 110° C.		0.0%		
105° to 170° C.		3.0%	8.0%	0.0%
170° to 225° C.		4.5%	6.0%	0.0%
170° to 235° C.		8.5%		
225° to 270° C.		17.5%	8.0%	2.3%
235° to 270° C.		13.5%		
270° to 300° C.		7.5%	14.0%	8.1%

(1) According to methods proposed by special committee, American Society of Civil Engineers.
(2) According to methods proposed by sub-committee of committee D-4, American Society for Testing Materials.

Conditions on Government Irrigation Projects

Views of Director Newell, Who Has Recently Completed Tour of Investigation in Nine States

THE director of the Reclamation Service, F. H. Newell, has just returned to Washington after an extended tour of investigation of the big engineering works of the Government in Montana, Washington, Idaho, Oregon, California, Utah, Nevada, Arizona and New Mexico.

"With excellent crops and good prices the settlers on our projects are rounding out the year in a very cheerful frame of mind," said Mr. Newell. "Bankers and merchants report more real money in circulation than in previous years, old debts are being cancelled and credit is more readily obtained. Paradoxical as it may seem, the prosperity of 1913 has been accompanied by a general lowering in land prices. Most land values in the irrigated West were unduly advanced during the past five years until they had reached a point where the West no longer continued to attract the people of moderate means. Future development of the agricultural lands of the arid West is to be accomplished by a more intelligent effort to secure settlers who will cultivate the soil rather than speculate on the advance in land prices.

OPPORTUNITIES OF THE WEST

"There is a better appreciation to-day of the real difficulties incident to subduing a desert farm and also of the fact that the West still offers opportunities to men of moderate means as well as to men without ready money but of average intelligence and frugality who are willing to work hard. Actual failures on the Government projects are relatively few in number, and at the present time it would appear that a fairly permanent class of settlers is now established on the farms. There is a marked change also in the attitude of the public toward Government activities in reclamation. In former years unfavorable comparisons were drawn concerning the cost of Federal work, but in the light of the financial difficulties which have been encountered by private enterprises and of the failure of many of these to furnish a dependable water supply, the wisdom of the Government's larger outlay is no longer questioned.

"The confidence in the future of these irrigated lands is based upon the excellent crop returns for 1913. The average value per acre of products grown on the new Government farms is almost exactly the same as the average for the products grown on irrigated lands under older systems. There is everywhere in the West urgent request for more rapid extension of Federal activity and several of the Western States have made special appropriations for co-operation with the Reclamation Service."

THE COST OF UNLOADING COAL from vessels into elevated coal bunkers or storage piles has been reduced by the New York Edison Company, in New York City, from more than 25 cents per ton originally to a present cost of not more than 2 cents per ton, where trimming in the pile or bunker may be left out of the question. This, according to Mr. George A. Orrok, in a paper read before the American Society of Mechanical Engineers, is the result of an extensive study of the question of coal handling on piers and involves mechanical handling equipment properly designed for this purpose.

Book Reviews

Circular 45, recently issued by the Bureau of Standards, treats of the testing of materials. It is designed to outline briefly with respect to each class of material the tests usually made, the conditions under which such work is undertaken, and some of the limitations due to the status of technical knowledge. The treatment is not intended to be complete. The circular is meant primarily for the user or buyer of materials rather than for the industrial expert. It explains for whom and under what conditions tests are made. In the latter part of the circular are schedules of fees. (Washington, D. C., Bureau of Standards.)

Simplified Formulas and Tables for Floors, Joists and Beams; Roofs, Rafters and Purlins. By Prof. N. Clifford Ricker. Cloth, 6 x 9 in.; 77 pages. New York, John Wiley & Sons. $1.50 net.
(Reviewed by Frank H. Constant, Professor of Structural Engineering, University of Minnesota.)

This book has been written for the twofold purpose of emphasizing the fact that in the design of beams both the formulæ for safety against rupture and for safety against excessive deflection must be applied and of simplifying such formulæ for convenient application in practice. The maximum allowable deflection is taken at 1/360 of the span length. The general procedure is to find I/c in terms of load, span and fiber stress for safety against rupture, and the I in terms of load, span and modulus of elasticity for the limiting allowable deflection. The beam section is then selected to satisfy both of these values of I/c and I. By transposing the formulæ the two limiting span lengths are found for a given beam loading, fiber stress and E for the two conditions of safety against rupture and excessive deflection, the smaller one then governing. Evidently further combinations can be made between the two sets of formulæ, as, for instance, the limiting span L can be expressed in terms of E, c and F (the fiber stress).

The simplification of the formulæ is effected by expressing the loading, fiber stress and E in tons, instead of pounds, span length in feet instead of inches and moments in foot-tons instead of inch-pounds. The author of the book believes that the numerical coefficients are reduced to smaller, and, therefore, more simple quantities.

The main value of the book lies in the systematic tabulation of the thus simplified formulæ for all of the ordinary cases of beam flexure—viz., the cantilever and the one-span beam, simply supported or with the various forms of end constraint. Only the two simplest cases of loading are considered, the uniformly distributed and the single concentration placed at the point producing the maximum moment. Each of the eighteen tables occupies a double page and covers one of the cases. The first column contains the general simplified formulæ for that particular case in nine different forms for I/c, I, W, L and Δ, for maximum safe fiber stress F, or safe deflection $L/30$, or for combinations of the two conditions. The remaining nine columns give the particular values of the above formulæ when the numerical constants are introduced for steel, cast iron, and seven kinds of wood. Some of the tables have especial reference to joists and contain the spacing of joists e and the loading per square foot. Tables 19 and 20 give the values of I and I/c for rectangular beams for widths and depths from 1 to 24 in. Tables 21, 22 and 23 give the values of I and I/c for cast iron lintels for the usual shapes from 6 to 28 in. in depth, and a table of four-place logarithms closes the book.

The tables occupy 47 of the 77 pages. The remaining 30 pages are explanatory of the process of transforming and simplifying the formulæ, and a number of numerical examples are given to illustrate the method of applying them. This part of the book must be considered quite unsatisfactory. Although intended to illuminate the tables, which form the heart of the book, no mention is made of them in the text until the numerical examples are reached. A short, concise and clear explanation of the meaning and use of the tables and the notation employed, covering two or three pages at most, would have sufficed for so simple a subject. Instead, the text is unnecessarily confused, is hard to understand, and contains many errors in typography and some in theory. The confusion in notation, the careless proofreading and errors in principle create in the mind of the reader a feeling of uncertainty as to the reliability of other parts of the book.

The use of the book will be limited to architects and architectural students who have to compute many such beams for the simple cases of loading here treated, and for whom the question of limiting deflection (where plastered ceilings are to be supported) is important. The work of the engineer generally carries him far afield beyond the limits of these tables and the design of his beams is nearly always governed by strength determination, not by deflection.

Reinforced Concrete Construction. Vol. II. By George A. Hool, S.B., Associate Professor of Structural Engineering, University of Wisconsin. Cloth, 6¼ x 9 in.; 666 pages; 409 illustrations. New York, McGraw-Hill Book Company, Inc. $5 net.
(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota.)

Volume I, which forms the first part of the course on reinforced concrete given by the Extension Division of the University of Wisconsin, was issued to meet the needs of correspondence students. It covers the fundamental principles which relate to rectangular beams, slabs, girders and columns. Volume II, which has just appeared, is considerably larger and includes 666 pages. Its essential aim is to present the details of practical design, and it covers, specifically, retaining walls (Part I) and buildings (Part II). It, like Volume I, is written for extension work, and on this account, the author states, it is somewhat more comprehensive than the ordinary text book. It evidences, however, the same maturity which characterized the first volume.

Part I (64 pages) covers earth pressure, the theory of stability and the design and construction of retaining walls. The Rankin theory of earth pressure is given, but the author prefers the more empirical method of finding an equivalent fluid pressure which, acting upon the ordinary gravity wall, will cause the resultant to intersect the base at the outer edge of the middle third.

Part II contains three sections—on design, construction and estimating respectively. The book closes with an appendix containing the last report of the Joint Committee on Reinforced Concrete as it appears in the "Proceedings" of the American Society of Civil Engineers, February, 1913.

The book is essentially descriptive and concerned with the multitudinous details entering into the various forms of concrete construction. In this respect it is one of the best on the subject. It is well illustrated.

Some mention must be made of the theoretical portions of the book. In Chapter 4 (on floors) the usual methods of slab and girder design are followed. A design of a floor bay with one-way hollow tile is given in detail. A valuable feature is the series of plates showing working drawings and steel-bending schedules (a recent development of the draftsman's art). Although the author devotes about seventeen pages to the theory of the flat slab, he throws no new light on the subject and advocates methods now known to be incorrect.

In Chapter 8 a square column footing is designed in detail.

Chapter 13 will be of value to the student already familiar with the theory of the continuous girder. Valuable tables and diagrams show the variations in moments and shears for different conditions of loading in beams of from two spans up.

In Chapter 14 an attempt is made to determine the bending moments in columns due to unsymmetrical loading on the floor girders. Formulæ are given to find the slopes α of the axes of the beams where they meet the column, and assuming the columns to bend through the same angles the maximum moments in the latter are computed. These formulæ are taken from the appendix of the book entitled "Reinforced Concrete," by Faber and Bowie. Inasmuch as the average engineer is not very familiar with secondary stress methods, and the above-named work has not had a very wide circulation in this country, it is unfortunate that the author has not reproduced the derivation of these formulæ. His discussion, however, is of value in pointing out the existence of these secondary stresses and the absolute necessity of using low compressive units in column design.

Chapter 15 discusses the wind stresses in a high narrow building without diagonal bracing, considered as a vertical cantilever. The method is put forth only as an approximation, the assumptions made not being at all in accordance with the facts. It must be regarded merely as one possible safe path by which the wind forces may reach the ground.

The book should be judged in the main by its practical aspect, and the great amount of new data and descriptive detail will make it an invaluable reference work for engineers and all others interested in reinforced-concrete construction. The typographical work is excellent and the cuts and reproductions are clear and inviting.

Letters to the Editor

New York's Water Power and the Right of Eminent Domain

Sir: The instructive article on page 517 of your issue of Nov. 8, 1913, is subject to two corrections—the first of minor importance, but the second of great weight.

The New England "mill acts," assuming that they are all modeled after the mill acts of Massachusetts, with which the writer is most familiar, do not grant "the right of eminent domain to mill owners." They only permit a mill owner to flow land upstream from the mill owner's dam. To that extent, and no more, do they grant the right of eminent domain.

Secondly, in the State of New York the drainage of agricultural lands is not a "public use" endowed with the right of eminent domain. The part of Article 1, Section 7, Constitution of New York, which thus endowed it was declared unconstitutional with respect to the "Federal Constitution" by a divided court, in 1900 (see Matter of Tuthill, N. Y. Rep. 163).

In 1894 I sent a circular letter to every delegate-elect of the Constitutional Convention of that year, pointing out the great advantages that the State of New York would derive from granting the right of eminent domain to facilitate the construction of works serving to "retain, exclude or convey water for agricultural, mining, milling, domestic or sanitary purposes."

The letter gave constitutional precedents, citing the then constitutions of Missouri, Colorado, Illinois, California, Idaho, Montana, Washington and Wyoming. It also referred to certain statutes of Virginia, Alabama, Delaware, Florida, Kentucky, Mississippi, Arkansas, Indiana, Iowa, West Virginia, Missouri and Illinois that point in the same direction, and contained an account of how such legislation has operated in foreign countries, where in one form or another it has existed for thousands of years.

So important to the welfare of future generations did I consider the subject that to save this letter referred to and its arguments from more or less oblivion, I went out of my way and added it as an appendix to the book "Frontinus and the Water Supply of the City of Rome."

Moved by the consideration recited, I proposed this amendment to the Constitution of New York: To insert in Article 1, Section 7: "The necessary use of lands for the construction and operation of works serving to retain, exclude or convey water for agricultural, mining, milling, domestic or sanitary purposes is hereby declared to be a public use."

This amendment was also personally presented and argued before the Committee on Amendments to the Constitution by my lawyer friend, William F. Upson, of New York City.

But the Convention, in its wisdom, mutilated the expression of the idea involved, as presented to it, as well as curtailed its possible benefits, by inserting instead the following: "General laws may be passed, permitting the owners or occupants of agricultural lands to construct and maintain for the drainage thereof necessary drains, ditches and dikes upon the lands of others, under proper restrictions and with just compensation, but no special laws shall be enacted for such purposes."

Upon which Governor Morton recommended legislation under the amended Section 7; the legislature passed L. 1895, Ch. 384 (note the dates); action was taken under this statute by one Tuthill and others; objected to and objection sustained in an order and judgment of the Appellate Division of the Supreme Court in the second judicial department, entered Jan. 30, 1899; decided in the Court of Appeals, May 15, 1900; order and judgment appealed from, affirmed, with costs.

I have, however, a letter from John G. Milburn (the name will be recognized as one carrying weight), who argued the case in the Court of Appeals for the farmers who wanted to convert their worthless lands into land which they could plow, in which, under date of June 18, 1900, he says: "I was greatly embarrassed in my case by the restricted language of the constitutional amendment of 1894. Had the convention adopted the amendment as you proposed it, I would have had no trouble with my case."

I am thankful that I have lived to see others recognize the propriety of the volunteer work I did in 1894 in the cause of general human welfare, as exhibited in the article in the Engineering Record above referred to. In some matters man can prophesy, if he is only sufficiently informed. And thus venturing to prophesy, I should say that some such valid legislation as was intended to be authorized by the constitutional amendment I proposed in 1894 must follow. Taking, for example, Italy, one can readily see that it could not support the population it does support upon its soil without the so-called "right of passage," permitting the builders of irrigation ditches to build them, under proper restrictions, of course, through the lands of others.

With the progress of the arts, and the constantly increasing density of population, the time must come, or is even now here, when "the necessary use of lands for the construction and operation of works serving to retain, exclude or convey water for agricultural, mining, milling, domestic or sanitary purposes" must be "declared to be a public use."

New York. CLEMENS HERSCHEL.

Collapse of Concrete Building at Cedar Rapids, Iowa

Sir: The partial failure of the seven-story reinforced-concrete Stark-Lyman building in Cedar Rapids, Iowa, described in the Engineering Record of Nov. 22, Current News Section, and Nov. 29, page 598, is of more than usual interest, because inquiry into the cause of the disaster can be confined within narrow limits. The specifications were drawn up according to good standard practice, the design of the reinforced-concrete work was prepared by a competent firm of contractors and submitted to and approved by an expert of reputation in this class of work. The cement was of a reliable brand and "was all tested"; no tests or inspection of the twisted bars are mentioned, but these were only strained to part of their final stresses.

As it appears, therefore, that no reasonable doubt can be entertained in regard to two of the fundamental conditions for the success of any building—design and materials—the cause of the collapse has to be looked for in the actual construction of the building. The data given in the article in your issue of Nov. 22 are meager, but they give the very important information that the fourth floor was poured or was begun to be poured on Oct. 4; the fifth floor on Oct. 13, the sixth floor on Oct. 23, the seventh floor on Nov. 1 and that part of the roof on the rear end of the building had been poured Nov. 14. In other words, the concrete work had been "pushed" and forms and shoring removed to be re-used in upper stories. The contractor was anxious to get the building "under roof" before real winter set in. This, in the writer's opinion, explains the disaster, and further consideration will show that the immediate cause is to be looked for in failure of one or more of the columns, rather than in the breaking of girders or slabs.

Let us consider the case of one of the inner third-story columns (date of pouring stated as Oct. 4). Twenty-eight days after it has been poured, with its form removed and shoring in lower stories taken out, it has to carry the panel loads of the fourth, fifth, sixth and seventh floors. Six weeks after its pouring the roof load is added. The dead load per square foot or floors, including slab girder and column (assuming 75 lb. per square foot for the weight of the tile floor and 20 lb. per square foot for girders and columns), is about equal to the prescribed live load. It follows that on Nov. 1 the third-story inner columns carried about one-half of the load for which they had been designed, minus the weight of the roof; on Nov. 14 some of these columns in the rear of the building carried the full half of their final load.

Tests on the crushing strength of concrete, from four to six weeks old, vary a good deal, the extreme values for a 1:2:4 mixture being about 1500 and 2500 lb. per square inch. But all these tests were made on small cubes or cylinders under favorable conditions as to shape, temperature, etc. What load a 12-ft. column will safety carry after a lapse of four or six weeks of cold weather we do not know and never will know. This is not a case of applied mechanics but of judgment and experience, and they tell us that a time for hardening which might be sufficient in the summer months is utterly inadequate in winter months.

If the Stark-Lyman building had to be built during winter and an early completion was all-important, the safe method would have been to keep the columns relieved of the weight of the floors throughout the progress of the concrete work by well-braced, substantial supports under all girders firmly supported on the ground.

The "average temperature slightly above freezing," or "as low as 26 deg. Fahr. on some days," was not low enough to injure the concrete, but it was certainly low enough to retard its hardening, and the writer is convinced that heavy loading on the "green" concrete in the columns fully explains the disaster.

St. Louis, Mo. CARL GAYLER, C.E.

Ratings for Valuation Engineers

Sir: Some interesting comparisons may now be made concerning three classes of candidates for positions under the Interstate Commerce Commission for the valuation of the property of common carriers. The number of successful applicants for three classes is given out as 1021. The number of applications for these three classes was 3887. The number of applicants, the number passed and percentage passed for each of the classes is given below:

	Number of applicants	Number passed	Per cent
Senior structural engineers....	707	106	15
Senior civil engineers..........	3,034	860	28
Senior railway-signal engineers	146	55	38

Since both structural and civil engineers have the same fundamentals in engineering schools, and the requirements for passing are the same as to years and experience, it is not clear why the civils have been able to pass 28 per cent of their number as against 15 per cent of the structurals. If the three general classes are now grouped as shown in the following table, the resulting figures are even more interesting:

Senior Structural Engineers—707 Applications		
Rating	Number passed	Per cent
Above 90	12	1.7
80-90	50	7.0
70-80	44	6.2
Senior Civil Engineers—3034 Applications		
Above 90	54	1.7
80-90	358	11.8
70-80	448	14.8
Senior Railway-Signal Engineers—146 Applications		
Above 90	2	1.4
80-90	19	13.0
70-80	34	23.1

It will be noted that although in the previous table the percentage of civils passing is almost twice that of structurals, in this table, in the grade "above 90," they stand on an equal footing; while if the three classes are considered the percentages are identical for practical purposes; the sudden increase in percentage in the 80-90 grades for all classes is also noticeable.

Other comparisons suggest themselves, but attention may be directed to the narrow limits of the percentages in the structurals, to the increased limits of the civils and the maximum in the signals. This may be shown more clearly in the following table:

Grade	Structurals,		Civils		Signals	
	No.	Per cent	No.	Per cent	No.	Per cent
Over 90......	12	11.3	54	6.3	2	3.6
80-90......	50	47.0	358	41.6	19	34.5
70-80......	44	41.5	448	52.0	34	61.8
Total....	106	100	860	100	55	100

Reviewed briefly, the percentage of applicants passing in the grade "Over 90" for each of the three general classes is practically the same, exactly the same for each of the two general classes. The percentage passing "over 90" in each class is greatest for the structurals, followed by the civils, and is low in the signals; this applies also for the 80-90 grade; but in the 70-80 grade the figures are reversed. The reason for this reversal is not apparent, nor why the structurals with such a high percentage of their number passing "over 90"—11.3 per cent—compared with 6.3 per cent for the civils—should have an equal percentage—1.7 per cent—compared with civils of applications passed.

It is to be regretted that the U. S. Civil Service Commission has not laid stress on the matter of knowledge of costs and prices; for of two engineers of equal technical knowledge, experience and executive ability that one is undoubtedly the better equipped for service with the Interstate Commerce Commission who has had to do with costs and prices. "Designing and supervising of construction" is not an indispensable consideration. There are many men in the United States, particularly in the large cities, known as building estimators who have at their fingers' ends the costs and prices of all kinds of materials entering into building construction and other kinds of structures, acquired after years of effort, but without the "designing and supervising" experience and with only little knowledge of engineering. This class of men would have been of valuable assistance to the work of valuation, and it is a matter of regret that some provision was not made for including them.

Further, since the business of building construction is subdivided into so many trades or professions, each of which requires the services of a highly trained specialist, it is obvious that the architectural and structural engineer can be interested in the "designing and supervising of construction" primarily, and only secondarily, or not at all, in detail costs and prices, depending largely on the building contractor, who is "up" on this matter, to make or furnish an "approximate" or "close" estimate, as circumstances require. There are structural engineers, as also architects, who combine a technical knowledge with knowledge of costs and prices; but the U. S. Civil Service Commission in its prospectus for this valuation work has apparently not recognized this class of men, because it has not provided for an increased rating where such knowledge could be shown to exist, although this valuable qualification is so absolutely essential to valuation work. In the Department of Buildings, Bureau of Appraisal, Public Service Commission, First District, New York, among the architects and structural engineers certified to the commission by the State Civil Service Commission for the express purpose of valuation—the property of the street railways being under consideration—this lack of precise knowledge of costs and prices was painfully apparent, though in nowise a reflection, because the State Civil Service Commission in its invitation to candidates had not given due consideration to this particularly needful qualification. Appraisal work satisfactory to both the railroads and the Interstate Commerce Commission can only be done by experts in their particular line. The Interstate Commerce Commission will discover this and be compelled to take the necessary steps to rectify this defect among the applicants for engineering positions in the Federal railway-valuation work.

J. Bodine Wright, C.E.,
New York City. M. Am. Soc. C. E.

Logging Engineering

Sir: I have noticed in your columns lately several articles on logging engineering, emphasizing the need of special training for this new branch of the profession. In your issue of Nov. 29 reference is specially made to logging in the West. Conditions are somewhat different in the South, but the need of such engineers is equally apparent.

There seems to be very little variation here in the cost or methods of sawing, but there is a most decided variation in the methods and costs of getting the logs to the mill. Most of this work is done by logging railways built for this purpose—some narrow gage and others standard. In some cases watercourses are used to float logs to the mill, and sometimes a combination of both water and rail is utilized. The rails are usually light weight, from 35 to 60 lb., rarely exceeding the latter, and too often less. Ties are usually plentiful and good. In recent years most of the larger concerns have taken into their employ a civil engineer, principally to run out land lines, keep the land records, etc. Where railroads are used he is given the task of laying these out also. But the idea that a real engineer can not only do these things best but could also well take charge of the whole system of logging has not yet pervaded the minds of most of the mill operatives. A number of them have been backward enough not to employ an engineer at all, relying on the ordinary county surveyors to run their land lines and leaving the location and building of the railroads to some so-called "practical railroad man," who usually knows how to maintain good track when he has a chance, but who has practically no knowledge of location science. Still another type is the practical woodsman, who is expert at estimating timber. He learns to run out land lines after a fashion, and for the lack of a better substitute he is given charge of building the railroads. Some of these men, by dint of long experience, get to be very proficient in their line, but a great deal of their experience is obtained at great expense to the mill company, and they too often lack the engineer's training which enables him to see all aspects at one time. There are probably few engineers at this time who are prepared or trained to meet all the demands made by such a concern, but it is doubtless true that an engineer so trained would be the best possible man to have in absolute charge of the department, and the necessity for such training is obvious.

The expense which could be saved in the judicious building of the railroads for logging alone would pay the engineer's salary over and over; and yet it is astounding to note the indifference with which this subject is treated by so many of the large sawmills. The writer has seen framed trestles made over small hollows—requiring skilled labor and expensive timber—to avoid moving a few hundred yards of earth. In one special case the trestle was several hundred feet long and only 5 or 6 ft. high. Being of rich pine timber, it had easily caught fire and had caused a wreck of a logging train. After a short tieup the trestle was rebuilt, only to be burned again within a few days. This is given as an example of the waste of inexperience.

In the South generally it is noticeable that less knowledge of the engineering profession exists, with consequent less use of its great advantages. In the case of sawmills, however, a great many of which are controlled by Northern men, this does not apply. One of the best-managed mills of which the writer has knowledge is owned and operated by Southern-born men. On the other hand, some of the poorest-managed ones are run by Northern men. Especially is this noticeable, as I have said before, in the logging department. A certain mill, for example, in this section had a logging railroad about 14 miles in length. It was reported as being in good condition, and the proposition of buying it and making it a commercial road was taken up. The writer was retained to make a survey and report. Forty-five-pound rail only was used. The joints were laid even, in some places on sharp curves. The trestles were in a few cases roughly framed, but were mostly made up of large logs thrown across the stream upon which ordinary cross-ties were laid, often without a guard rail to prevent bunching. Accidents were frequent. Ordinary freshets would submerge the roadbed and cause washouts. On one occasion a fine new logging engine was turned over in a creek, the driver escaping death only by a miracle. As to alignment, it could be said almost truthfully that there was none. Even on straight, level stretches a real straight, true tangent could not be found, and very sharp curves had been introduced frequently simply to avoid a few yards of grading or to miss a few bad stumps. It was out of the question to establish a commercial line out of it, so the general route was followed, but not a foot of the logging road was adopted. The line was shortened to about 12 miles, and in those 12 miles the new line crossed the logging road fourteen times.

And yet that particular sawmill had timber along that route for at least twenty years' cutting! Is it not time to wake up?

L. W. Duffee,
Assoc. M. Am. Soc. C. E.
Meridian, Miss.

Electrolysis of Water Pipes in Seattle, Wash., has caused much damage, it is reported, especially in the case of wood-stave pipe wrapped with continuous steel wire. Wood-stave pipes have been laid in some of the city's streets largely because of the rapid growth in population and the consequent temporary nature of the water-distribution system. The service pipes from the mains to the buildings and the steel-riveted pipe are also affected a great deal. Cast-iron pipes are subject to the same action, but owing to the larger volume of metal they do not deteriorate as rapidly as the other kinds. In the vicinity of street-railway substations the deterioration has been much more rapid than elsewhere, often resulting in the complete destruction of the bands, and even the disintegration of large cast-iron pipes.